AERONAUTICAL ENGINEERING REVIEW

INSTITUTE OF THE AERONAUTICAL SCIENCES

FEBRUARY 1950

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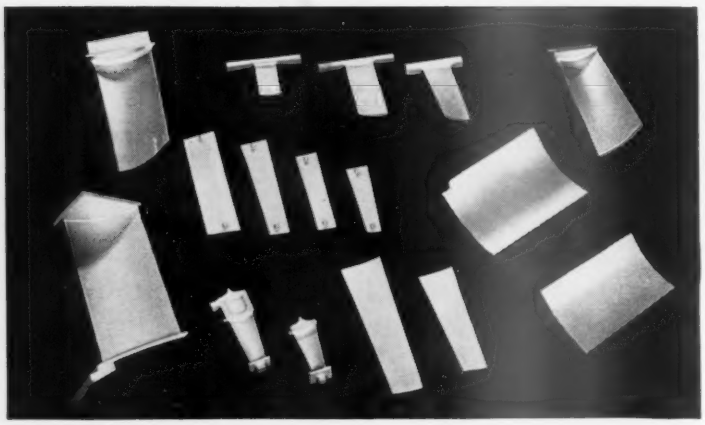
SPECIALISTS IN POWER BLADING



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Cover—U.S.A.F. Fairchild C-119 dropping water ballast from cargo hold.

Editor
Welman A. Shrader

Technical Advisers
Hugh L. Dryden Robert R. Dexter
S. Paul Johnston

Associate Editor Bernice H. Jarck
Managing Editor John J. Glennon
News Editor Randolph Hawthorne
Reviews Editor Lyons T. Carr

Manager
Joseph P. Ryan

Manager, Western Region
James L. Straight
7660 Beverly Blvd., Los Angeles 36, Calif.

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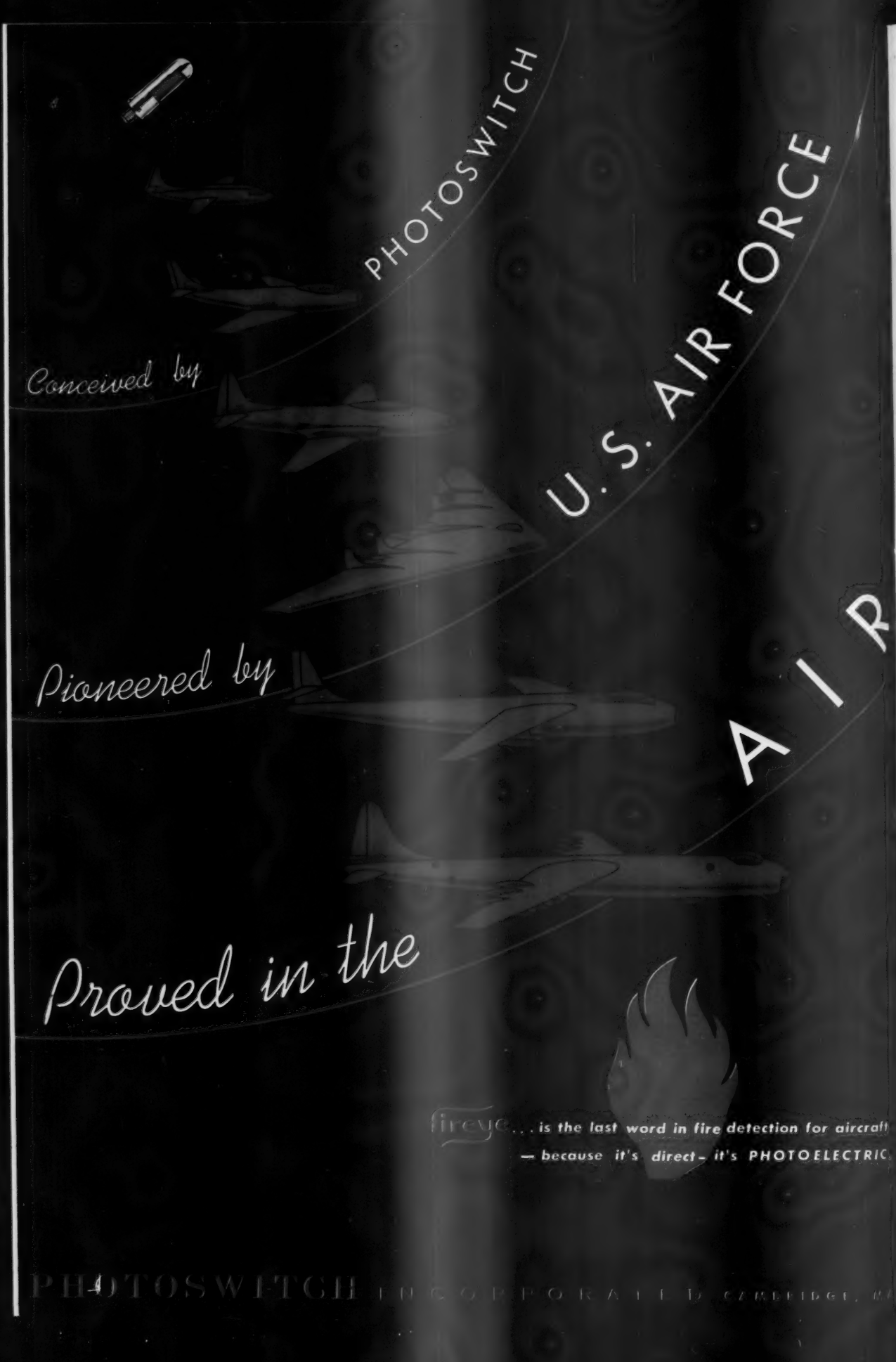
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I.A.S. News

A Record of People and Events of Interest to Institute Members

March Propulsion Meeting to Feature Jet Transport Application

Cleveland-Akron Section Program Committee Preparing Interesting Program Covering Jet and Turboprop, Nuclear Energy Applications to Aircraft Propulsion; N.A.C.A. Staff Planning Evening Symposium on Icing Problems.

THE FIFTH ANNUAL PROPULSION MEETING of the Institute of the Aeronautical Sciences, to be held at the Hotel Carter in Cleveland, March 24, will present varied and yet solid food for thought according to present planning by the Program Committee, headed by Dr. S. Doree Black, Vice-Chairman, Cleveland-Akron Section.

▸ **Old and New**—In the Morning Session, it is planned to have a mixture of such subjects as guided missiles, modern propeller development, application of nuclear energy, and problems of turboprop engines discussed by prominent engineers.

The Afternoon Session will be devoted to Jet Transport Applications, with speakers representing the airline and manufacturing points of view. Among the latter, it is hoped to obtain a speaker from the A. V. Roe Canada Ltd. plant, producers of the first jet transport to be developed in the Western Hemisphere, the C.102 Avro Jetliner.

For the evening, the N.A.C.A. is presenting a Symposium on Icing Problems of Jet Transports.

▲ **Three Parts**—The first part of the Symposium will be a study in cloud physics—the causes of icing and the nature of the icing environment to be considered by jet-transport designers.

In the second part, the different types of ice-protection systems applicable to turbine-powered transports will be described and discussed, and, in the third part, the effect of the various ice-detecting and anti-icing systems on the performance of the aircraft will be investigated. Two four-engined aircraft types—a turboprop and a pure jet—will be used to study the effects on performance caused by ice-protection systems.

Chairman Arch T. Colwell of the Cleveland-Akron Section will welcome Institute members to the meeting in the Hotel Carter.

Members of the Program Committee are: Dr. Black, Chairman; Abe Silverstein; E. W. "Gene" Wasielewski; Howard F. Powders; Willson H. Hunter; and William A. Fleming, Secretary-Treasurer of the Section.

A bigger and better technical exhibit is planned for this year's meeting. It will be devoted to jet components and accessories made in the Cleveland-Akron area. In addition, there will be social entertainment in the form of a luncheon and a dinner.

Propulsion Meeting Host: *Arch T. Colwell, Chairman of the Cleveland-Akron Section, will be host at the Propulsion Meeting in Cleveland on March 24.*

Sparks Propulsion Program: *Dr. S. Doree Black, Associate Professor of Aeronautical Engineering, Case Institute of Technology, Chairman of the Program Committee responsible for setting up the annual Cleveland meeting this year.*

National Meetings Calendar

March 24	Flight Propulsion Meeting, Cleveland
July 12–14	Annual Summer Meeting, Los Angeles

(For details see page 93)

"Air Cargo Day" Points Up Increasing Importance of New Field for Air Transport Operations

All-Day Event Included Technical Papers, Inspection Trip to World's Air-Cargo Center at Newark, Speech by General Tunner, MATS Deputy Commander for Operations; Air-Cargo Exhibit Shown at Statler Hotel

THE I.A.S. COSPONSORED with the A.S.M.E. and the S.A.E. an interest-packed Air Cargo Day last November 29 at the A.S.M.E. 70th Annual Meeting in the Hotel Statler in New York.

In addition to five technical papers presented in morning and evening sessions, an inspection trip was made to nearby Newark Airport, a world center for air cargo, where equipment and functioning of seven air cargo terminals was shown and explained and a demonstration of cargo handling equipment was made.

▶ **Air-Cargo Exhibit**—A focal point of interest was the exhibit in the Keystone Room Foyer of model cargo planes and an operating model of a future Air Cargo Terminal shown by Lockheed Aircraft Corporation. Called the Lockheed Air Freight Terminal, the model illustrated extendable loading ramps or bridges, which made exact spotting of aircraft unnecessary, equipped with accordian conveyors, while on the loading platform where cargo is processed, moving conveyors transported goods in loading and unloading operations. The terminal could accommodate four planes of Constellation or DC-6 types at the same time.

Chase Aircraft Company, Inc., exhibited its C-122 and XC-123 models, while another table held models of the Douglas C-74 and C-124 Globemasters, DC-6, and others.

The Military Air Transport Service, exhibited a model of the famous Berlin Airlift routes.

▶ **Morning Sessions** — Beginning at 9:30 in the morning, three technical papers were given in the Keystone Room of the Statler, with Robert B. Lea, A.M.I.A.S., Sperry Gyroscope Company, presiding as Chairman.

Crowd-Drawer: *Operating model of future Air Cargo Terminal exhibited by Lockheed Aircraft drew continuous groups of interested onlookers in the Keystone Room Foyer.*

The first paper, "Air Cargo Today—It is Here to Stay," prepared by Charles Froesch, F.I.A.S., was read by Robert R. Stark, T.M.I.A.S.

One of the points made by the paper is that air cargo is here to stay because it meets a definite business need and affords savings in the transport of high-value merchandise. It was also observed that no air-cargo plane designed as such is available for commercial use in this country.

The second paper, by W. W. Davies, Director of Engineering, United Air Lines, Inc., covered "What Should be Done to Improve Cargo Aircraft." In this paper, Mr. Davies advocated adapting and modifying present equipment as an interim arrangement until specially designed cargo craft could be developed. "Air cargo," he declared, somewhat contradictory to Mr. Froesch, "isn't here—yet. It is in the development stage."

R. Dixon Speas, Special Assistant to the President, American Airlines System, gave the third and last paper of the morning session. His subject, "Improvements Required in Air Cargo Ground Handling," was illuminated by his humorous "popcorn" story and the description of tests by the National Safe Transit Committee which found that most shocks to cargo occur in ground handling.

The discussion that followed was participated in by Air Force Colonel Culbertson, of Wright-Patterson A.F. Base; Rear Adm. Lawrence B. Richardson, U.S.N. (Ret.); William F. Sauers, Executive Engineer of Chase Aircraft Company, Inc.; and numerous others.

▶ **Dryden Speaks** — The Luncheon held in the Statler's Ball Room was the occasion for the presentation of a testimonial by the A.S.M.E. to Donald F. Warner for his contributions to the development of the jet engine in America. Mr. Warner is a General Electric engineer at the Lynn, Mass., plant.

Principal speaker was Dr. Hugh L. Dryden, F.I.A.S., Director of Research, N.A.C.A. Dr. Dryden declared that America must build air power and stock-pile atomic bombs in order that the peace may be maintained. These, he said, would act as deterrents to the warlike intentions of other nations, much as the revolver and club of the policeman tend to keep the peace in the community.

Dr. Dryden stressed the importance of maintaining technologic leadership as the only hope of obtaining air

Calls for Air Truck: *Major Gen. William H. Tunner tells Air Cargo Day session that U.S. has need of a rugged "truck of the air" to move its forces anywhere in the world.*

Cargo Transport Evolution: *Douglas Aircraft displayed an effective exhibit of the growth of air-cargo design as represented in Douglas, Lockheed, and Boeing transports.*

power sufficient to serve as an instrument of peace.

▸ **Inspection Trip**—After the Luncheon, three buses picked up full loads of members for a trip to Newark, where cargo handling was explained and demonstrated in a guided tour of the various air-line facilities. Eastern Air Lines' Speed Pak, Trans World Airlines' Power conveyors, Slick Airways' demonstration of cargo handling, American Airlines' methods, and a demonstration of loading a new Ford car into the Douglas Liftmaster were viewed by the crowd of more than a hundred members in the visiting party. Coffee and doughnuts were served by American to the appreciative guests.

The huge C-74 Globemaster of M.A.T.S. was also inspected.

The party then was taken by the buses to the Essex Hotel in Newark for a buffet dinner and then returned to the Statler in New York for the evening session, which commenced at 8:15.

▸ **"Air Truck" Crucial**—Major Gen. William H. Tunner, Deputy Commander for Operations, M.A.T.S., recent commander of the Combined Air Lift Task Force in Germany, in the first speech of the session, delcared that the United States had need of a rugged "truck of the air" for getting its forces anywhere in the world and supplying them continuously.

Primary consideration in the design of such a four-engined transport, he went on, must be that it is able to accomplish its mission with maximum economy. Among the design considerations stressed by the general were:

- Safety and dependability.
- Ease and simplicity of maintenance.
- Ease of loading and unloading from normal truck bodies with the minimum use of auxiliary equipment.
- Fuselage design sufficiently wide to permit storing two passenger-type vehicles or equivalent items side by side throughout its usable length. A density factor of 10 lbs. per cu.ft. to accommodate a 25-ton load is desirable.
- Cargo doors, more than one, must be ample in size to permit loading of a 6 × 6 truck with its canopy; and monorails provided for movement of heavy cargo within the interior of the plane.

The second speaker of the evening was L. R. Hackney, Air Cargo Sales Engineer, Lockheed Aircraft Corporation.

Mr. Hackney declared that development of the "vast unexploited air-freight potential" can be accomplished through improved ground handling and loading of air freight and that until such time as adequate and intelligently planned terminals are provided for the air-freight industry, its expansion will be retarded.

▸ **Military Value**—Properly designed and equipped standardized air freight terminals, Mr. Hackney pointed out, can be of untold value in the event of national emergency. They could be used by the Military Air Transport Service to supplement their existing facilities, for in war there always is a need to requisition and transport vast supplies of critically needed materials.

Mr. Hackney discussed objectives that need be considered for an air-freight terminal and the analysis necessary to meet such objectives. Applying these generalized principles to a specific example, he summarized findings of the Lockheed Aircraft Corporation and its subsidiary concerning the problem of improved cargo-handling facilities at Lockheed Air Terminal.

DC-6A Loading Demonstration: *American Airlines stows a new Ford car in the hold of a DC-6A Douglas Liftmaster in a demonstration at Newark Airport for inspection group.*

First Convertible Aircraft Congress Held in Philadelphia on December 9

I.A.S. and A.H.S. Members Discuss Design Problems and Applications at All-Day Meeting; Proceedings to Be Published This Month

THE FIRST CONVERTIBLE AIRCRAFT CONGRESS, sponsored jointly by the Philadelphia Section of the I.A.S. and the American Helicopter Society, was held on December 9 in the Ballroom of the Warwick Hotel in Philadelphia.

More than 200 enthusiastic participants discussed the problem of combining into a single aircraft the vertical- and hovering-flight characteristics of the helicopter and the longer range and higher speed of the conventional fixed-wing airplane. Those attending the Congress, the first to deal solely with problems of convertible aircraft, represented helicopter, airplane, and engine manufacturers and research and development agencies of the U.S. Government.

▶**Technical Sessions**—Ten papers were presented at the two technical sessions, three motion pictures were shown, and a model rotor illustrating transition from vertical to horizontal flight was demonstrated. Richard H. Prewitt, A.F.I.A.S., President, Prewitt Aircraft Company, and W. Laurence Le Page, A.F.I.A.S., Consulting Engineer, were chairmen of the morning and afternoon sessions, respectively.

▶**Old Timers' Luncheon**—Focusing attention on past achievements in the field of rotating wing and convertible aircraft, E. Burke Wilford, M.I.A.S., Chairman of the Congress Committee, awarded silver plaques to pioneer designers and pilots of aircraft of these types. E. Burke Wilford was also honored with a silver plaque "for his pioneering concept, development, and promotion of convertible aircraft, presented by the General Committee, First Convertible Aircraft Congress." The presentation was made by Dr. Alexander Klemin, F.I.A.S., Technical Editor, *Aero Digest*.

Gerard P. Herrick holds silver plaque commemorating his invention of the Convertoplane. Presentation was made by E. Burke Wilford. Ralph H. McClarren, applauding Mr. Wilford's action, received plaque for his work as "engineer in charge of first Convertoplane." George Townson *(extreme right)*, "test pilot of the first Convertoplane," was similarly honored. Plaque awarded to Dr. George F. Myers, M.I.A.S., Patent Attorney *(seated)* cited his "first attempted helicopter flight in America, November, 1904."

Left to right: **Paul H. Stanley, A.F.I.A.S., Chief Engineer, Autogiro Company of America, and James G. Ray are congratulated by E. Burke Wilford after receiving award for "first autogiro flight in America, December 18, 1928." Harold F. Pitcairn, A.M.I.A.S., who shared in award, was unable to be present. Lew Leavitt *(extreme right)* was honored for the "first aircraft landing on a building, Philadelphia Post Office, May 25, 1935."**

▶**Reception and Dinner**—After the close of the last technical session of the Congress at 5:00 p.m., members and their guests attended a reception in the Ballroom lounge.

C. S. "Casey" Jones, A.F.I.A.S., President, Academy of Aeronautics, acted as Toastmaster at the Dinner, which began at 6:30 p.m. Guests-of-honor and principal speakers were Major D. G. Cogswell, Air Division, Development Section, U.S. Army, Fort Monroe, Va.; Charles H. Zimmerman, A.F.I.A.S., Aeronautical Research Scientist, Langley Aeronautical Laboratory, N.A.C.A.; Rear Adm. C. M. Bolster, H.M.I.A.S., Assistant Chief for Research and Development,

Bureau of Aeronautics, Navy Department; and Major Gen. Donald L. Putt, H.M.I.A.S., Director of Research and Development, U.S.A.F.

▸**Printed Proceedings**—The Proceedings of the Technical Sessions of the First Convertible Aircraft Congress are in preparation, and copies will be ready for distribution during the month of February. The Proceedings will contain the texts and discussions of all papers delivered before the Congress, as follows:

Morning Session

"Semi-Rigid Rotors for Convertible Aircraft," Glidden Doman, President, Doman Helicopter Corporation (read by Giles Montgomery).

"Higher Flight Speeds for Rotary-Wing Aircraft by Combination with Fixed Wing," K. Hohenemser, Chief Aerodynamicist, Helicopter Division, McDonnell Aircraft Corporation.

"Design Studies of Various Tilting-Fuselage Convertible Aircraft," Lloyd Leonard, formerly N.A.C.A. and Thompson Industries.

"New Approach to Convertibility," A. Flettner, President, American Flettner Corporation.

"Performance and Stability of a Convertible Aircraft," Charles Zimmerman, Langley Aeronautical Laboratory, N.A.C.A.

Afternoon Session

"The Development of the Convertoplane," Gerard P. Herrick, President, Convertoplane Corporation.

"Naval Uses for Convertible Aircraft," Lt. Comdr. William Knapp, U.S.N.R., V.O.S. Desk, Bureau of Aeronautics, Navy Department.

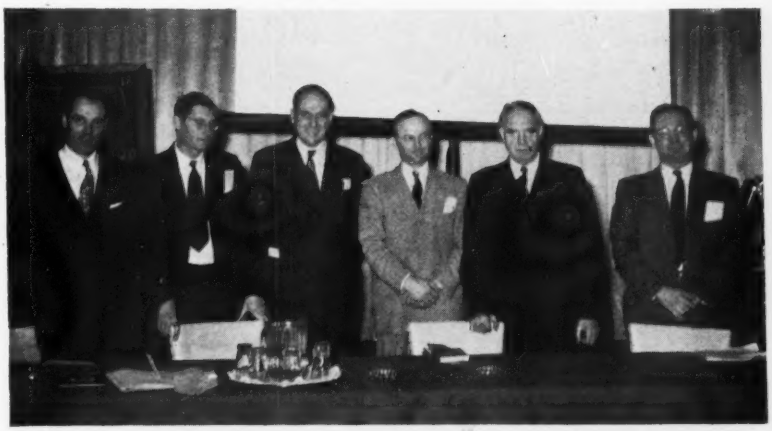
"Will the Convertible Aircraft Break the Bonds of the Present Restricted Market for Private Aircraft?" Roland Rohlfs, Personal Flying Specialist for Assistant to Regional Administrator, C.A.A. Region 1

"Configurations of Convertible Aircraft," Viscount Louis de Monge de Franeau, Consultant, Pennsylvania Aircraft Syndicate, Ltd.

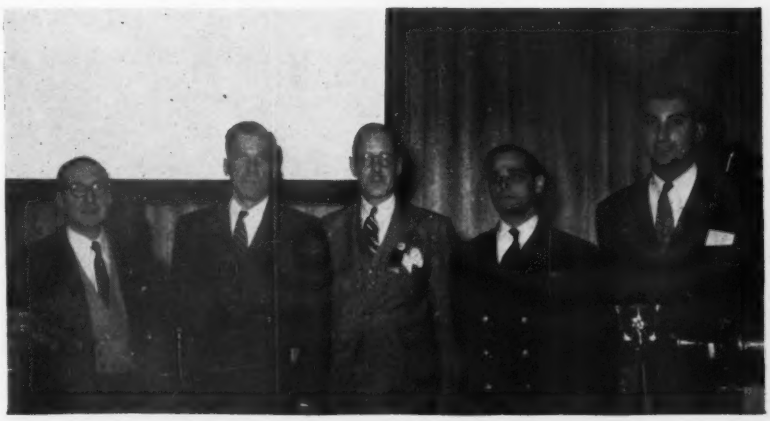
"Conversion from Propeller to Lifting Rotor Operation After Power Failure," Robert L. Lichten, Project Engineer, Bell Aircraft Corporation.

Members of the Institute of the Aeronautical Sciences or the American Helicopter Society may purchase these proceedings at $3.00 per copy, postpaid. The price to others is $5.00 per copy, postpaid. Orders should be sent to the Preprint Department, Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y. Since only a limited edition is being published, those wishing to obtain copies should place their orders as soon as possible.

E. Burke Wilford announces awards to *(left to right)*: W. Wallace Kellett, A.M.I.A.S., President, Kellett Aircraft Corporation [on behalf of Joseph (deceased) and William McCormick, autogiro pilots who accompanied Admiral Byrd to South Pole]; to Paul E. Hovgard, F.I.A.S., for "first gyroplane flight with rotor under full control and without fixed wing, Wings Field, Pa., October 1, 1932"; and to Comdr. Frank Brown, for "first cyclic controlled gyroplane flight in America, Paoli, Pa., August 5, 1931." Seated at table is Dr. George F. Myers.



Speakers at the Morning Session *(left to right)*: Giles Montgomery (who read paper for Glidden Doman); K. Hohenemser; Richard H. Prewitt, Chairman; Lloyd Leonard; A. Flettner; and Charles Zimmerman.



Speakers at the Afternoon Session *(left to right)*: Viscount Louis de Monge de Franeau; Roland Rohlfs; W. Laurence Le Page, Chairman; Lt. Comdr. William Knapp, U.S.N.R.; and Robert L. Lichten. Not shown is Gerard P. Herrick, who delivered paper on "The Development of the Convertoplane."

Thirteenth Wright Brothers Lecture

Presented by A. E. Russell Before Three Audiences on East and West Coasts

THE WRIGHT BROTHERS LECTURE, presented annually by the Institute to commemorate the anniversary of the first airplane flight, was a thrice-repeated performance this year by popular request of West Coast members. In addition to the traditional December 17 presentation in Washington, the lecture was delivered before equally enthusiastic audiences in Los Angeles and Seattle on December 19 and 22, respectively. Thus, more than 1,000 Institute members and guests were privileged to hear personally and to meet the honored guest and well-known British aircraft designer, A. E. Russell, of The Bristol Aeroplane Company, Ltd.

Approximately 500 people gathered in the U.S. Chamber of Commerce Building Auditorium in Washington on December 17 to hear the first lecture. I.A.S. President, W. A. M. Burden, made the opening address, in which he welcomed the speaker to this country and explained the endowment of The Vernon Lynch Fund, which provides for this annual lecture.

William Littlewood, Vice President—Engineering, American Airlines, Inc., acted as Chairman of the program and cited Mr. Russell's achievements before introducing him to the audience.

Prepared discussions of the paper followed the lecture. These were presented by R. M. Hazen, Director of Engineering, Allison Division, General Motors Corporation; Nicholas J. Hoff, Professor of Aeronautical Engineering, Polytechnic Institute of Brooklyn; R. D. Kelly, Superintendent, Technical Development, United Air Lines, Inc.; and Abe Silverstein, Chief of Research, Lewis Flight Propulsion Laboratory, N.A.C.A.

An informal reception for Mr. Russell and other participants in the program was held at the Army and Navy Club in the early evening.

▶ **Presentation at Los Angeles**—The Institute's West Coast Headquarters' building provided the setting for the second delivery of the Lecture and for the dinner that preceded it on December 19. Two hundred guests were present at dinner, and more than 350 attended the lecture. This marks the largest meeting yet held in the Los Angeles building's auditorium.

Comments on the lecture were prepared by Edward C. Wells, Vice-President—Engineering, Boeing Airplane Company, and Frank W. Fink, Chief Engineer, San Diego Division, Consolidated Vultee Aircraft Corporation. Mr. Fink's written comments were read by Ernest G. Stout, Assistant to Chief Engineer, Consolidated Vultee Aircraft Corporation, in Mr Fink's absence. Mr. Stout also added some comments of his own.

Thirteenth Wright Brothers Lecturer: *A. E. Russell, Chief Engineer (Aircraft), The Bristol Aeroplane Company, Ltd., London.*

Discussers of Lecture at Washington: (*Left to right*) *Nicholas J. Hoff, Professor of Aeronautical Engineering, Polytechnic Institute of Brooklyn; Abe Silverstein, Chief of Research, Lewis Flight Propulsion Laboratory, N.A.C.A.; R. M. Hazen, Director of Engineering, Allison Division, General Motors Corporation; R. D. Kelly, Superintendent, Technical Development, United Air Lines, Inc.; and William Littlewood, Vice-President—Engineering, American Airlines, Inc., Chairman of the Lecture.*

▶ **Seattle Lecture**—Mr. Russell presented his lecture for the third time before a group of 300 in the Guggenheim Auditorium on the University of Washington campus in Seattle on the evening of December 22. Brief comments in this instance were given by George S. Schairer, Staff Engineer, Aerodynamics and Power Plant; Edward Rock, Burkeley Kinnaman, and Howard Smith—all of Boeing Airplane Company.

Boeing played host to Mr. Russell at a luncheon in the plant's cafeteria, and the Seattle Section of the I.A.S. did the honors at a dinner at the Seattle Tennis Club in the evening.

▶ **Lecture Published**—For the benefit of those members who were unable to hear Mr. Russell's talks, the complete Thirteenth Wright Brothers Lecture and discussions are being published in the February issue of the JOURNAL OF THE AERONAUTICAL SCIENCES. The March JOURNAL will contain a reply by Mr. Russell to the discussions.

Necrology

Gen. H. H. Arnold

GENERAL OF THE AIR FORCE Henry Harley Arnold, H.F.I.A.S., died of a heart condition on January 15 at his ranch in the Valley of the Moon, near Sonoma, Calif. He was 63 years of age.

▸ **Flyer Since 1911**—General Arnold received his flight training from the Wright brothers in 1911, 4 years after his graduation from the U.S. Military Academy at West Point. He rose to be wartime commander of the greatest air force in history, an organization of some 2,500,000 men and more than 70,000 aircraft.

A champion of air power, he remained a vigorous supporter of air power for peace after his retirement in January, 1946.

General Arnold was the first in U.S. military aviation history to receive four-star rank when he was promoted in March, 1943, and in December, 1944, he was made a five-star General of the Army.

Born in Gladwyne, Pa., he was graduated from West Point in 1907 and was nearly broken-hearted when he was assigned to the 29th Infantry in the Philippines, having aspired to the cavalry.

However, when he returned to this country in 1910 for reassignment to Governors Island, he made a flight in a Curtiss biplane as a passenger, which gave him his first interest in planes. In 1911 he applied for, and received, a transfer to the Signal Corps at Dayton for training by the Wright brothers, Wilbur and Orville.

▸ **Won Mackay Trophy**—In 1912 he was awarded the Mackay Trophy for aviation achievement, making a reconnaissance flight from College Park, Md., to Washington to Ft. Myer, Va., and back to College Park in an early Wright biplane.

Gen. Henry Harley Arnold.

Twenty-two years later he won the trophy again for an 18,000-mile flight of ten Army bombers from Washington to Alaska.

Since his retirement in 1946, General Arnold has lived quietly on his ranch, writing occasional articles for newspapers and magazines. His last book, *Global Mission*, an autobiography, was published in September, 1949.

International Organization Admits U.S. National Committee

The International Union of Theoretical and Applied Mechanics has admitted the U.S. National Committee on Theoretical and Applied Mechanics, recently organized by seven national scientific and engineering societies, including the I.A.S., according to a message from Dr. J. M. Burgers, Secretary of the Union, which has headquarters in Delft, Holland.

In addition to the Institute, member organizations of the U.S. Committee are: Society for Experimental Stress Analysis, American Society of Civil Engineers, American Institute of Chemical Engineers, Fluid Dynamics Section of the American Physical Society, American Mathematical Society, and the American Society of Mechanical Engineers.

▸ **Committee Members**—Hugh L. Dryden, H.F.I.A.S., is Chairman of the Committee; C. E. Davies, M.I.A.S., is Secretary-Treasurer. Representing member societies are H. W. Emmons, A.S.M.E.; R. D. Mindlin, S.E.S.A.; M. G. Salvadori, A.S.C.E.; T. B. Drew, A.I.Ch.E.; Dr. R. J. Seeger, A.F.I.A.S., A.P.S.; Dr. Nicholas J. Hoff, A.F.I.A.S., I.A.S.; and E. Reissner, A.F.I.A.S., A.M.S. Members at large are Dr. Theodore von Kármán, H.F.I.A.S., S. Timoshenko, F.I.A.S., Dr. J. C. Hunsaker, H.F.I.A.S., and R. von Mises, F.I.A.S.

New Fairey Method of Aircraft Construction

Details of a revolutionary method of aircraft construction were reported by The Fairey Aviation Company Ltd., of which Sir Richard Fairey, H.F.I.A.S., is Chairman and Managing Director. The method is in use in building the company's latest type, the Fairey 17 antisubmarine aircraft,

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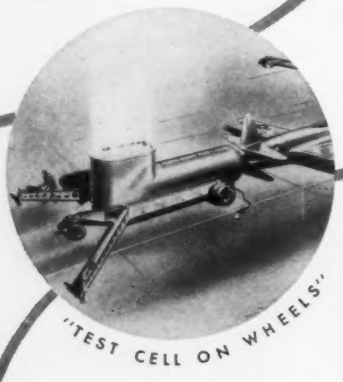

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powered by the Double Mamba propjet engine.

▶ **Reverse Practice**—Principle of the Fairey method—evolved after intensive study of British and American practice—is that the *outside* skin of the plane is accurately shaped in "envelope" jigs before any of the *inside* structure is fitted. This is the exact reverse of long-standing practice, wherein the skin is attached after the inside structure is built.

In practice, the basic principle involves the use of standardized jig fittings designed for flexibility of employment and suitable for a wide range of construction components and for any aircraft shape. Major innovation of the Fairey jig system is that the production jigs can be erected as soon as the prototype aircraft's basic geometry has been determined.

▶ **Advantages Claimed**—Chief advantages claimed for the new method are an unprecedented degree of accuracy in construction, with elimination of even minor building errors, resulting in complete interchangeability of parts from the No. 1 aircraft.

Furthermore, by closely integrated collaboration between various sections of the aircraft and jig design staffs, development of a prototype is governed from the start with a view to the eventual production line, Fairey says.

Consequently, it is claimed, the method brings with it an increased potential in the effective rate of output, of vital importance in times of strategic or economic emergency.

Drexel Institute Receives Late John Rogers Library

The widow of the late John Rogers, Mrs. Emily Rogers, who presented to the I.A.S. Library a collection of the former Secretary of the I.A.S. Philadelphia Section consisting of books, manuals, and periodicals early last year, has made a second gift, this time to the Drexel Institute, his alma mater.

▶ **Technical Library**—The gift, consisting of John Rogers' technical library, carries with it funds contributed by the Philadelphia Section for acquiring additional books as needed.

In presenting the gift on behalf of the Section, Alfred L. Wolf, Chairman, said:

"I can remember John Rogers through his entire aeronautical career in Philadelphia, first as an engineer at Camden Airport, later as the principal of the Rising Sun School of Aeronautics, not only Philadelphia's, but one of the country's leading airplane and engine mechanic schools, and then later after a few years spent in Con-

the new

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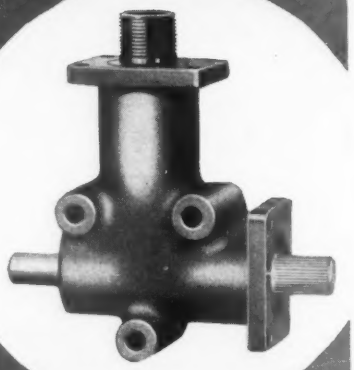

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necticut with the state aeronautical schools, on his return here as Works Manager of Metlab Company, which is the position he held at the time of his death."

"In representing the Philadelphia Section of the I.A.S.," Mr. Wolf continued, "I can say with no fear of rebuke from my associates in the Section that John Rogers' contribution to the Section was not only an inspiration, but a necessity to its survival and success for several years. It was John's devotion to his engineering career and to his professional interests, possibly too altruistically applied, which contributed to his early death. I hope that when the students at Drexel use these books in the future they will be inspired to future donations to aviation nearly as great as that made by John Rogers."

Walter H. Beech Scholarship at University of Wichita

A personal gift of $8,000 for the establishment of several 4-year scholarships in aeronautical engineering has been made by Walter H. Beech, M.I.A.S., President and Chairman of the Board, Beech Aircraft Corporation, to the University of Wichita, it has been announced by the university.

Outstanding Kansas high-school graduates seeking careers in aviation will compete for the newly established scholarships on the campus this spring.

Each winner will receive a $1,600 grant—$400 per year. The competitive examinations will be held annually on the Wichita campus.

Hamilton Standard Streamlines Prop Strip Analysis Method

The importance of modern propeller designs to the performance and economy of the latest transports has been revealed in a special memorandum being circulated by Hamilton Standard Division of United Aircraft Corporation.

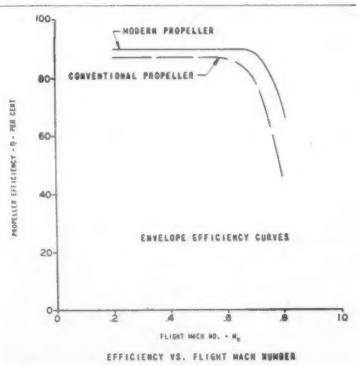
Increases in prop efficiency as small as 1 or 2 per cent can increase an airplane's pay load from 10 to as much as 50 per cent, the memorandum points out. In the DC-6, for example, an increase in the camber of the blade airfoil sections, as worked out by the strip-analysis method, afforded a 3 per cent improvement in prop efficiency during initial climb. This improvement made possible a 1,400-lb. increase in the DC-6's maximum permissible gross weight.

▸ **Method Long in Use**—The strip-analysis method, as it is known, has been in existence for many years, but originally was very laborious, time-consuming, and expensive.

Hamilton Standard undertook an extensive development program to streamline the method as a production tool, with the result that the time required for a complete performance analysis has been reduced by 75 per cent. Over the past five years, with the increasing requirement for prop installations of maximum efficiency and the accumulation of extensive test data proving Hamstan's calculations, the method has been used for the rapid and accurate evaluation of existing designs in addition to its important application in the design of new refined blades.

▸ **Its Validity**—Since strip analysis had been founded on a purely theoretical form of analysis, the memo states, there was considerable doubt expressed about its validity in providing an accurate means of comparing performance of different prop designs. However, results of wind-tunnel and flight tests have proved the accuracy of the method.

For example, in 1939, flight tests on the Douglas DC-3 indicated a submarginal rate of climb. Strip analysis indicated that the propulsive efficiency could be improved $1^1/_2$ per cent merely by retwisting the blades. When the blades were modified, flight tests demonstrated an improvement in the rate of climb exactly equivalent to the increase in efficiency predicted by strip analysis.



Strip Analysis Results: *Propeller performance improvements resulting from strip analysis as shown in Hamilton Standard tests.*

Other notable examples and extensive comparisons between wind-tunnel test results and performance computed by strip analysis have shown that the comparative accuracy of the method is approximately ±0.5 per cent.

▸ **Its Future**—Since in the operation of strip analysis, the memo continues, it is necessary to use the appropriate lift and drag data of the particular family of airfoils incorporated in the blade design, the accuracy of the computed prop performance is directly dependent on the accuracy of the airfoil data available.

Though complete and reliable airfoil data are available for speed conditions below the advent of severe compressibility losses, there is a paucity of such data for propeller blade operation in the transonic range. It has been necessary to use estimated airfoil data for such cases, with the realization that considerable inaccuracies may be introduced.

In spite of this fact, significant advances in the design of high-speed propellers have already been accomplished, Hamilton Standard declares. Although the performance improvements cannot yet be predicted precisely, the design concepts have been well confirmed by wind-tunnel tests comparing these new high-speed designs with the conventional types, according to the memo.

The established design criteria require the development of wide square-tipped blades incorporating airfoils with low camber and low thickness-to-width ratios. The latter requirement, says Hamilton Standard, is the most important, but the extent to which thickness-to-width ratios can be reduced is limited by structural considerations. Since the war, Hamilton Standard has already been able to reduce the blade thickness-to-width ratios of its production models by 50 per cent.

Application of such refinements as these, concludes the memo, has resulted in the performance improvements shown in the accompanying graph, which should serve to extend the useful operating range of the propeller.

Various research facilities are presently engaged in extensive programs to obtain accurate airfoil data in the transonic range. When such data is made available, it seems certain that the accuracy currently exhibited by strip analysis will be available for the design and analysis of propellers for the high subsonic and transonic ranges, Hamilton Standard believes.

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Nicholas J. Hoff Honored by Swedish Engineers

For the first time an American aeronautical scientist, Dr. Nicholas J. Hoff, A.F.I.A.S., has been awarded the medal of the Swedish Society of Engineers, which, through its aeronautical section, has been awarded to only two other aeronautical scientists in the past 15 years.

▶ **Visited Sweden**—The medal was awarded during Dr. Hoff's recent visit to Sweden, where he presented a paper before the Society, as an appreciation of his outstanding scientific achievement and as a token of gratitude for his activities in Sweden, according to a report in the Swedish newspaper, *Svenska Dagladet.*

Dr. Hoff, who is Professor of Aeronautical Engineering at Polytechnic Institute of Brooklyn, has won international recognition for his contributions to the science of structural engineering, particularly with respect to his work on the general instability of airplane fuselages, on the buckling of rigid jointed trusses, on the effects of concentrated loads on fuselage frames, and on the bending and buckling of sandwich-type structural elements.

In his research at Polytechnic he has developed methods of analysis for thin-walled monocoque and sandwich construction.

▶ **Presents New Approach**—In his talk before the Swedish Society, and later at a symposium in Bristol, England, Dr. Hoff presented a new approach to the investigation of the load-carrying capacity of a structural element when loaded in compression, which replaces the old static equations of equilibrium with dynamic equations of motion. The whole problem of buckling is one of major concern to aeronautical engineers today as speeds increase and planes must withstand resulting terrific air pressures.

I.A.S. Newslines

▶ Boeing's Beall Proposal . . . A proposal that C.A.A. sponsor construction of new jet transports and lease them to U.S. scheduled airlines was voiced by **Wellwood E. Beall,** F.I.A.S., Vice-President for Engineering & Sales. Beall said the plan could be administered without major new legislation or creation of new federal agencies and with minimum of expense. Such a plan would give U.S. manu-

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facturers and air lines the answer to the problem of how to compete effectively with the threat of British domination of future air transportation, he said.

▶ Goddard Medal to Bolster . . . The American Rocket Society presented the Goddard Memorial Lecture Award, a gold medal, to **Rear Adm. Calvin M. Bolster,** U.S.N., H.M.I.-A.S., for "exceptional vision and leadership in support of research and development throughout the field of rocket propulsion. . ." The award was presented on the occasion of the Society's second annual Honors Night Dinner during the fourth annual convention in New York.

▶ Lindbergh Honored . . . The 1949 Wright Brothers Memorial Trophy was awarded to **Charles A. Lindbergh,** F.I.A.S., for outstanding public service in aviation in the past 22 years. The award was presented at the annual Wright Brothers Memorial Dinner held by the Washington Aero Club on December 17—46th anniversary of the first flight. Colonel Lindbergh, a special consultant to General H. S. Vandenberg, Air Force Chief of Staff, operates with fighter and bomber groups throughout the world. He was selected from some 15 nominees by a committee of aviation leaders.

▶ Jet Transport Jitters . . . **William Littlewood,** F.I.A.S., Vice-President—Engineering, American Airlines System, gave a talk before the A.S.M.E. Metropolitan Section in New York on December 15 on the subject of "Jet Transport Jitters—Here and in Great Britain," in which he discussed the various possibilities of jet transportation in England and the U.S. He also presented some of the operating problems which must be solved, most important of which he said were engine life, air-traffic control, and navigation.

▶ Returns to Lockheed . . . **Walter F. McGinty,** A.F.I.A.S., recently returned to Lockheed Aircraft Service, Inc., as Special Representative in the New York office. He formerly was General Manager, National Aircraft Maintenance Corporation.

Corporate Member News

• Airborne Accessories' Addition . . . Recent completion of a 2,200-sq.ft. addition to **Airborne Accessories Corporation's** factory at Hillside 5, N.J., permits expansion of their Engineering Department and Development Laboratory. Engineering Department has been transferred from offices in Newark to the new quarters, consolidating all the functions of the company in one location.

• DC-6 Coach Service in April . . . Work, begun last January, to outfit three of **American Airlines** DC-6's for air-coach service will be completed by April when they will go into service. Each will carry 70 coach passengers with fares ranging from $35 (New York–Chicago) to $110 (New York–Los Angeles).

• Beech Nets $922,089 . . . For fiscal 1949, ended September 30, **Beech Aircraft Corporation** realized a net income of $922,089 on net sales of $20,582,043. In his outline of prospects for 1950 business, Walter H. Beech, M.I.A.S., President, reported that although the backlog of business as of December 1, 1949, approximated $11,600,000, the company's backlog of the same date a year previous was approximately $14,700,000, reflecting a decrease in business backlog of more than $3,000,000. Further, he pointed out, deliveries for company's first fiscal quarter (October, November, December) were estimated at one-half compared to same quarter in 1948. . . . First deliveries of new Beech Twin-Bonanza to commercial customers have been tentatively scheduled for sometime in early fall. Present estimates on price indicate it will sell for approximately $30,000 delivered complete.

• Automatic Analyzer . . . **Douglas Aircraft Company** has developed for Army Ordnance an automatic analyzer that cuts 80 per cent of the time and cost involved in interpreting complicated data radioed from supersonic research rockets. The machine was designed to interpret data produced by a pulse-time telemeter system, which transmits readings from 28 instruments in the missile during flight. Signals are recorded by ground stations on continuously moving 35-mm. film in groups of 28 straight parallel lines measuring 0.004 in. in breadth. Quantities being measured are registered by varying lengths of these fine lines. Since some 900 lines are recorded on about 12 in. of film per sec. of flight, there may be as many as 150,000 readings to be checked and analyzed for a single flight. Analyzer also can automatically analyze data for wind-tunnel manometer records, said B. S. Benson, Douglas missiles research engineer, who worked on its development.

• Improved Magnesium Alloy . . . ZK60, an improved magnesium extrusion alloy containing 6 per cent zinc and 0.06 per cent zirconium, has shown increased toughness, relative insensitivity to notch effect, and good impact toughness and fatigue strength, **The Dow Chemical Company,** Midland, Mich., has announced. Tensile and compressive yield strengths of ZK60 are substantially the same, Dow Chemical says, whereas in other wrought magnesium alloys compressive yield is normally only 60–70 per cent of tensile yield strength. Among outstanding applications is use of ZK60 for floor beams in the DC-6 with a weight saving of 5 per cent and cost saving of 25 per cent. Other applications include the ZK60 spar cap in experimental magnesium wings on F-80 and use of the alloy in last 15 sets of SNJ and AT-6 wings produced under contract at Dow's magnesium fabricating plant in Bay City, Mich.

• Technical Assistance Agreement . . . Pacific Airmotive Corporation of Burbank, Calif., and **Stratos Corporation** of Farmingdale, L.I., N.Y., subsidiary of Fairchild Engine and Airplane Corporation, have

Fairchild Water Ballast Tanks: *Preparing for a stability and control test on the Fairchild C-119, a fire hose is used to fill the 720-gal aluminum water ballast tank while a sight gage is checked to show amount of water in the tank.*

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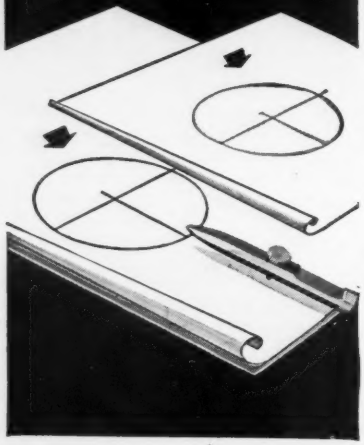

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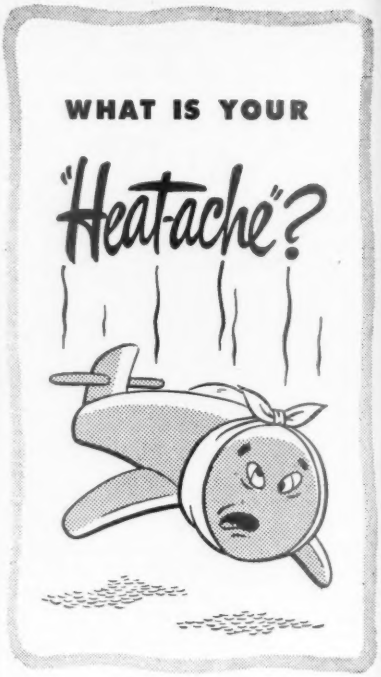
signed a technical assistance agreement whereby aircraft manufacturers will be able to obtain a fully coordinated pressurization and air-conditioning installation for military and commercial aircraft. Equipment is adaptable to both propeller and jet-driven planes. Both companies are in production on this equipment and the agreement makes it possible for any plane manufacturer to obtain for his own use the research discoveries and technical skill of the two corporations. Equipment ranges from units designed for single-place fighters to multiengined bombers. Stratos designs and manufactures a complete line of cabin air-conditioning equipment, consisting of superchargers, blowers, and cooling packages. Company has been appointed to act as eastern manufacturer's representative for pressurization control equipment made by Pacific Airmotive.

● Fairchild Backlog . . . A backlog of more than $90,000,000 was announced by Richard S. Boutelle, M.I.A.S., President, **Fairchild Engine and Airplane Corporation,** in his report to stockholders. . . While New Yorkers contemplate their low water reserves, thousands of gallons of the stuff are replacing heavy shot bags as ballast in experimental Fairchild C-119's in flight tests at Hagerstown, where shortages of water are unknown. By using water ballast, Fairchild flight-test engineers can duplicate any weight and balance loading that the C-119 will be required to carry. All cargo loading is based on a 74,000-lb. gross weight, with approximately 25,000 lbs. available for a useful load. Fairchild ballast system utilizes four 720-gal. riveted aluminum tanks mounted in the cargo compartment and a dual pumping system. The identical tank units are connected fore and aft in pairs for pumping and are secured to cargo tread area by 10,000-lb. tie-down fittings. Two surplus Rolls Royce Merlin pumps mounted between fore and aft tanks transfer the water at rate of 70 gal. per min. Dump valves in each tank release the water ballast through a 10-in. opening in the cargo-hold floor. Valves are electrically operated through actuators originally designed for C-82 wing flaps. A hand crank installed on each tank may be used to release water in case of power failure in the valve actuators. Sight gages on each tank show amount of water in the tanks, and a meter on pumping system indicates amount of water transferred from one tank to another.

● New Aircraft Energizer . . . A new lightweight ground power supply suitable for medium requirements of low-voltage d.c. power for aircraft, airports, and aircraft testing stations, has been announced by **General Electric's** Small and Medium Motor Divisions, Schenectady 5, N.Y. Supplementing the 500-amp. G-E energizer, this new 265-amp. 7.5-kw. unit was developed to meet demand for a smaller lightweight set for general-purpose use. High overload of 500 amp. for 1 min. and dual range of regulated voltage at both 14 and 28.5 volts provides a wide range of application for aircraft equipment.

● Globe Awarded Contract . . . A production contract by the Navy Department, Bureau of Aeronautics, has been awarded **Globe Corporation, Aircraft Division,**



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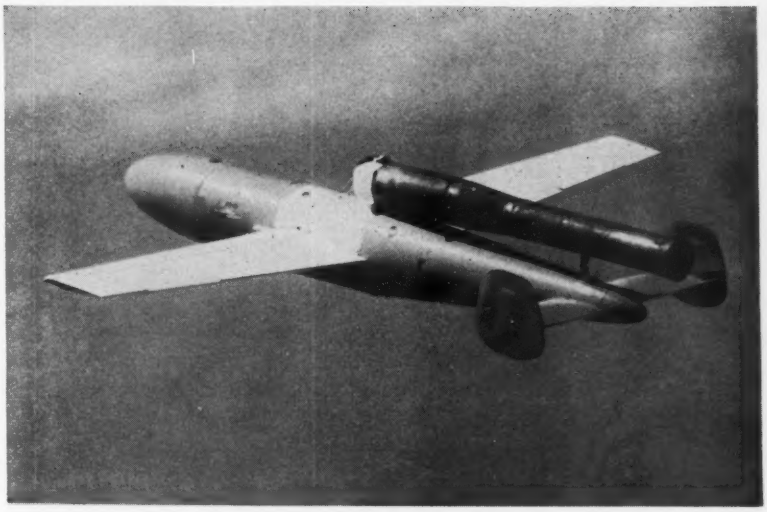
Joliet, Ill., for a sizable quantity of pulse-jet-powered pilotless aircraft targets. Target aircraft, designated Navy KD2G-2, is remotely controlled for air-to-air or anti-aircraft gunnery training and is designed for catapult launching from ground or air launching from a parent aircraft. The KD2G-2 is the result of some 3 years of development work by Globe in cooperation with BuAer, and is said to be first successful pulse-jet-powered target plane developed and released for production.

• Built-In Fire Protection . . . To ensure maximum safety in ground fueling operations, a new Texaco gasoline pump truck for servicing aircraft has a built-in carbon dioxide fire-extinguishing system guarding the engine and hydraulic supply tank. Made by **Walter Kidde & Company, Inc.,** the extinguisher includes a 25-lb.-capacity cylinder of compressed carbon dioxide in the pumping compartment, on the side of the truck, connected through a discharge head and rigid piping to a series of five nozzles located under the engine hood at front end of truck. Engine compartment houses the hydraulic supply tank as well as the truck engine. On the truck dashboard is a Kidde marine-type pull handle, which connects by flexible cable to the release mechanism on the cylinder discharge head. There are also two Luxstat fire detectors under the engine hood.

• **Link Aviation, Inc.,** has received two production contracts for Operational Flight Trainers. The Trainers, ordered by the Special Devices Center of the Office of Naval Research, will simulate the F3D-1 twinjet Skyknight and SNJ Texan. Twenty-seven of the SNJ Trainers are to be built, with deliveries starting early this year. In addition, four of the F3D's will be built for spring delivery, about the same time Douglas Aircraft delivers Skyknights to Navy. Unique feature of these models is that they will be self-contained within a mobile trailer unit, making possible easy transportation.

• Navy Orders Martin Boats . . . An initial production contract for the first postwar twin-engined flying boat to be developed by the Navy has been awarded **The Glenn L. Martin Company** for its P5M-1 seaplane. Designed to succeed the Martin Mariner series, the P5M-1 is primarily intended for antisubmarine warfare in any part of the world but will also serve as cargo or general-utility carriers. Gull-winged, it will have a single vertical stabilizer and a long afterbody sloping gently upward near the tail for better landing and take-off characteristics, especially on rough water.

• McDonnell "Taste Appeal" . . . Because **McDonnell Aircraft Corporation** workers are captive customers of the plant cafeteria, having no other place to eat, the company has its restaurant feature "taste appeal" through a different type of cuisine every month. One month Italian preparations are offered; next, French menus titillate McDonnell gourmets; then German cooking provides a solid basis for McDonnell morale and production. New plan, involving the use of tasty sauces, spectacular seasoning, and wines, increases the odds against the McDonnell cafeteria ever breaking even financially, but resultant losses are more than compensated by the boost in morale, says company spokesman. Lunch hour now means a new adventure . . . in a cafeteria now something more than a "refueling station."



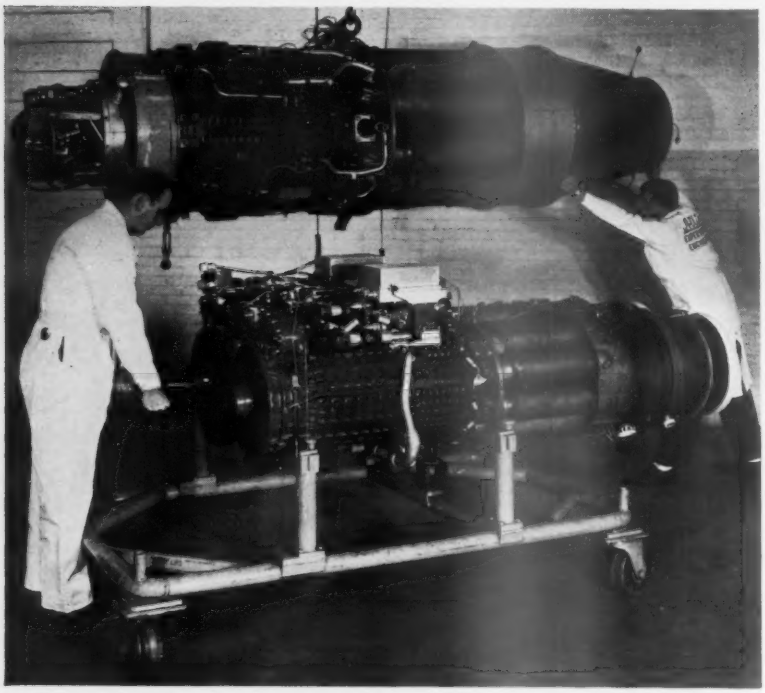
Globe Pilotless Aircraft Target: *Known as the KD2G-2, made by the Aircraft Division of Globe Corporation, this pulse-jet-powered pilotless aircraft target is remotely controlled from air or ground. It is retrieved by means of a parachute to permit re-use.*

• Supersensitive Electronic Control . . . A highly accurate and low-cost electronic control instrument, that for industrial applications is sensitive to temperature changes as small as 0.1°, has been developed by **Minneapolis-Honeywell Regulator Company,** 2753 4th Ave., South, Minneapolis 8, Minn. New device will control industrial processing temperatures in which temperature range is between 20° below zero and 300° above, company says. Known as No. 077, control is immune to vibration, dust, and dampness.

• Radar Trouble Shooter . . . A unique device that is said to quickly trouble-shoot

WARNER RECEIVES GUGGENHEIM MEDAL

For his pioneering research and a continuous record of contribution to the art and science of aeronautics, Dr. Edward P. Warner (2nd right), President of the Council, International Civil Aviation Organization, Montreal, Quebec, beamingly receives the Daniel Guggenheim Medal from Glenn L. Martin (3rd right), Chairman of the Board of The Glenn L. Martin Company, and Chairman of the Daniel Guggenheim Medal Board of Award. Left to right at the 70th Annual Meeting of the A.S.M.E. in the Hotel Statler are: Robert B. Lea; John H. R. Arms; Preston R. Bassett; Lester D. Gardner; Mr. Martin and Dr. Warner, and Lt. Gen. James H. Doolittle.



MOST POWERFUL PROP-JET

Said to be the most powerful propeller-type engine ever cleared for flight, the 5,500-hp. XT40 was developed for the U.S. Navy by Allison Division of General Motors in a project that began in December, 1945. New turboprop engine develops more than 2 hp. per lb. of engine weight. Fuel economy of the twin unit is said to approach the efficiency of the most powerful piston engines used in World War II. New design consists of two axial-flow gas-turbine power sections driving dual-rotation props through a common reduction gear. Each power section may be operated independently, permitting reduced power for cruising operations and maximum fuel economy by cutting out one power section after take-off. Four XT40's are installed in the Convair XP5Y flying boat. Small size of the turboprop is compared with J-35 turbojet shown above.

highly sensitive radar wiring on bombers has been developed at **North American Aviation, Inc.** Known as a continuity and megger checker, instrument is claimed to cut down time required to check radar wiring in the B-45 4-jet bomber from 360 hours to 8. Air Force has ordered 29 of the checkers for use on other-type bombers. By running 500 volts through the normal 24-volt radar system, "leaks" that normally would be difficult to locate can be found immediately with the new checker.

• Salud! . . . Final touch in air-travel luxury—wine and liquor service aloft—has been added to three more Latin American routes by **Pan American World Airways.** A choice of wines—compliments of P.A.A.—is now available on the flights (453 and 454) between Miami and Caracas, Venezuela. Flights 507 and 508 between Miami, Camaguey, Kingston, Jamaica; Barranquilla, Colombia, and Maracaibo, Venezuela, and flights 501 and 502 across north coast of South America between Panama and Port of Spain, Trinidad, also have the new service. In addition to table wines, a complete bar service is available on the flights . . . For first time in commercial aviation history, says Pan Am, C.A.A. has certified a training device as the equivalent of an actual aircraft when it approved the electronic flight simulator for the major part of the semiannual crew checks on its Boeing Clippers. The $250,000 flight simulator has been used by Pan Am for 14 months, and in that time 45 captains, 38 first officers, and 6 second officers have been trained in the operation of the Stratocruiser. During the 2,675 training hours the simulator has been in use, American Overseas Airlines has trained crews for 170 hours, and BOAC has checked out 36 crews. . . Four of Pan American's new-type Constellations, which were sold to Air France recently, actually were purchased by Air France in June, 1947, but were held pending receipt of Pan Am's fleet of Boeing Stratocruisers, delivery of which was delayed. Remaining 14 Connies of the Constellation-type Clipper fleet will continue to be operated.

• Parker Shuttle Valves . . . A 3,000-lb. per sq.in. shuttle valve, which meets or exceeds the rigorous aircraft requirements of Specification AN-V-3b, is announced by **The Parker Appliance Company,** 17325 Euclid Ave., Cleveland 12, Ohio. Although produced primarily for aircraft use, the shuttle valve is applicable to industrial systems where it is desired to alternate pressure sources to a cylinder or other device as precaution against emergencies, or for other design reasons. Built in tube sizes 6 ($^3/_8$-in. tube O.D.) and 8 ($^1/_2$-in. O.D.), the valve will shuttle against a closed line, and will not unseat from surge flows or negative pressures, company says. Nor will surge flows displace the synthetic rubber seat. No evidence of deformation or failure was shown at burst test pressures of 7,500 lbs. per sq.in., says Parker, adding that the valves have a pressure drop of less than the allowed maximum of 10 lbs. per sq.in. at rated flow. Under test, valves show zero leakage at static pressures of 5 and 3,000 lbs. per sq.in. or at proof pressure of 4,500 lbs. per sq.in.; zero leakage while shuttling under air or oil pressure; zero leakage, and only infinitesimal internal leakage after 20,000 cycles of impulse with peak pressures of 3,750 lbs. per sq.in. Also, zero leakage is shown while undergoing severe temperature changes from −65°F. to 160°F. After extensive endurance testing, Parker claims, these precision-built valves showed no change in characteristics or excessive wear, indicating assurance of long trouble-free service.

• Orenda's Endurance Test . . . The Orenda No. 1 jet engine, developed by **A. V. Roe Canada Ltd.,** Malton, Ontario, recently ran more than 750 hours without major rebuild or overhaul. Endurance run included the 150-hour U.S. Endurance Test Schedule; 25-hour British Ministry Special Category Test Schedule; 150-hour R.C.A.F. Type Test Schedule; 50-hour Preliminary Flight Rating Test Schedule (Canadian); 150-hour British Ministry Service Type Test for Turboprop and Turbojet engines; 50-hour Preliminary Flight Rating Test Schedule (U.S.); and approximately 175 hours of miscellaneous running, including performance running to simulate engine flight conditions, acceleration trials, and endurance running to measure consumptions. All the tests were carried out at the design rating of the engine. Only routine inspection and maintenance were carried out, and the only replacements of any significance comprised replacement of the flame tubes at the end of 300 hours and 600 hours and the replacement of 6 nozzle guide vanes which had become accidently damaged, Avro says.

• Super-Powered Navion . . . A new 260-hp. Lycoming-powered "Super" Navion which cruises at 170 m.p.h., climbs 1,250 ft. per min. with full load, and has comparable all-round high performance has been announced by **Ryan Aeronautical Company,** San Diego, Calif. Deliveries are scheduled to begin this March. . . Two other Ryan models, the 205-hp. De Luxe and Utility, started the year for Ryan, with the Utility selling for $9,485 f.a.f. San Diego, $1,500 less than the De Luxe 205.

• Paper on Precision Test Machine . . . **Westinghouse Electric Corporation,** 306 Fourth Ave., P.O. Box 1017, Pittsburgh 30, Pa., reports a paper presented to a meeting of the Society of Experimental Stress Analysis which describes the design and operation of a precision testing machine to determine the strength of gas-turbine discs. Written by Messrs. A. C. Hagg, B. Cametti, and G. O. Sankey, of the Westinghouse Research Laboratories, it is issued by the East Pittsburgh plant.

• Cyclones Ordered . . . Military orders totaling $12.25 million for three types of Cyclone engines have been received by the **Wright Aeronautical Corporation.** Larger of the two orders, amounting to slightly more than $10 million, was placed by the Navy and calls for additional production of Cyclone 18 engines of 2,700 hp. and Turbo-Cyclone 18 compound engines of 3,250 hp. Both types will power Navy attack and patrol bombers. Second order, placed by the Air Force, calls for a number of 1,425-hp. Cyclone 9 engines for a fleet of Grumman Albatross amphibian aircraft which will be used for air rescue and hospital work.

I.A.S. Sections

Buffalo Section

R. Allen Price, *Secretary*

More than 1,500 members of the Technical Societies Council of Buffalo attended the combined meeting at Kleinhans Music Hall on November 16 to hear E. M. Strieby of the Long Lines Division, Bell Telephone Company, describe the Division's part in the transmission of television programs in the U.S.

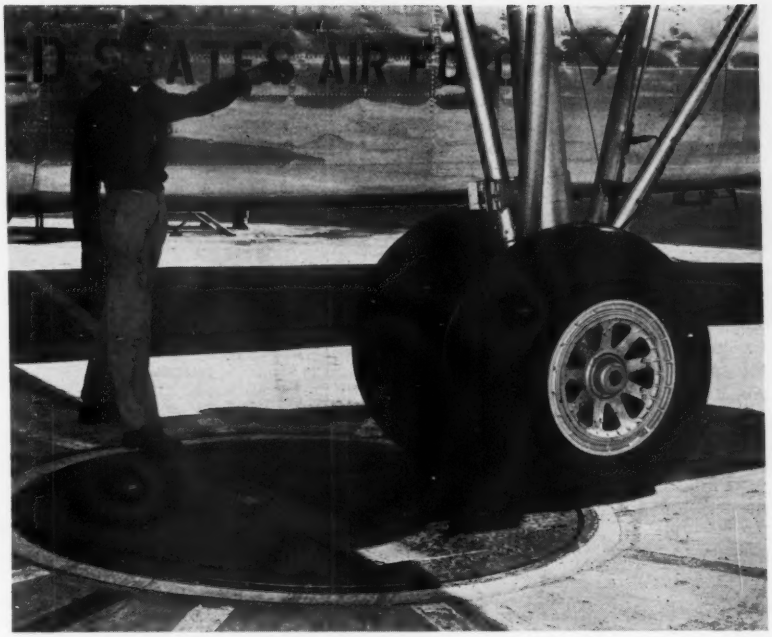
Movies and slides were shown of the developments and installations of Bell Telephone equipment in various parts of the country.

On December 7, Robert M. Williams, Chief, Aircraft Reactor Branch, Reactor Development Division, Atomic Energy Commission, gave a talk on "Development Problems of Turbojets."

▶ **Blade Problems**—In his talk, Mr. Williams, who drew upon his experience with Allison and Packard, said that when it is considered that turbine blades weighing 6 oz. deliver approximately 200 hp. to turbojet drive shafts in modern engines, the importance of current research aimed at increasing blade strength at elevated temperatures by use of superalloys or, conversely, by cooling the blades to reduce temperatures, is apparent.

Without question, he went on, cooling must be the ultimate answer since there are insufficient supplies of the alloying elements to supply production requirements. However, since perhaps the most important performance parameter is specific fuel consumption, except for special cases such as interceptor aircraft, and since specific fuel consumption increases with operating temperatures, it appears that optimum temperatures may not have to be as high as previously believed.

▶ **Predicts Axial Flow Type**—Mr. Williams predicted that the turbojet configuration eventually will consist of axial-flow compressors with fewer stages than now used, annular combustion chambers, and single-stage turbines employing cooled low-alloy blades, and will contain built-in provisions for afterburners.



NEW COMPASS "SWINGING" METHOD

Fairchild Aircraft Division claims it is the first major aircraft manufacturer to install a new system of "swinging" aircraft compasses. New installation, developed by Wakefield Engineering Company, Coeur d'Alene, Idaho, provides a faster, more accurate method of checking magnetic and fluxgate compasses, ADF and other navigational equipment in the Fairchild C-119 Packets. Replacing the obsolete compass rose, the Wakefield Compass Compensator consists of a 6½-ft. diam. turntable fabricated from aluminum alloy I-beams. It contains a shallow trough for aligning the dual wheels. Easy turning is accomplished by use of a patented plastic bearing. Turntable rotates on a bronze bearing plate set in concrete in center of the pit so that top of turntable is flush with the field. A remote indicating unit in pilot's cabin is connected with the turntable. Electric cable and power are contained in a small portable unit which is plugged into a connector on the turntable. In operation, the dual wheels are rolled onto the turntable and centered in the trough. Power unit is plugged in and indicator dial attached by electric cable to pilot's cabin. When plane is oriented to magnetic north, pilot's indicator reads north. From then on, exact headings are read on the pilot's indicator as the plane is swung to various headings and compasses compensated accordingly. Entire operation for the C-119 requires only 1½ hours instead of 6 usually necessary.

Dayton Section

Robert W. Hoeflein, *Secretary*

On November 17, some 40 members heard Robert Insley, Vice-President, Continental Aviation & Engineering Corporation, speak on "The Evolution of the 'Flat' Engine."

Detroit Section

Joseph Rutkowski, *Secretary*

Abe Silverstein, of the Lewis Flight Propulsion Laboratory, N.A.C.A., Cleveland, was the chief speaker at the November 9 meeting. Two-hundred and fifty persons were present with Chairman L. Patrick presiding.

▶ **Future Power Plants**—In his talk, "Supersonic Propulsion—Power Plants of the Future," Mr. Silverstein presented and discussed the elementary concepts of factors involved in supersonic propulsion: power requirements, altitude effects, and the relation of the various forms of power plants to these factors.

Slides showing the effect of the variables on power-plant performance presented a graphic elucidation.

Particular emphasis was placed on the operation of the N.A.C.A. 8- by 6-ft. supersonic wind tunnel. Movies were shown describing this and other test facilities, including rocket test stands and ram-jet tests.

Rockets and rocket fuels also were discussed. Flight-test techniques for acquiring aerodynamic data, including rocket firings, and drop tests were also described.

Seattle Section

Edward Z. Gray, *Secretary*

E. C. Wells, Vice-President—Engineering, Boeing Airplane Company,

Seattle, addressed 350 persons at the November 9 meeting on "An Engineer's Impression of Present-Day Europe."

Texas Section

David L. Mellen, *Secretary*

New slate of officers elected are as follows: Chairman, Russell J. McCrea; Vice-Chairman, W. Andrew Pitman; Secretary, David L. Mellen; and Treasurer, William C. Dietz. Executive Committee is composed of Henry B. Gibbons, Herbert W. Hinckley, Edward A. Kurzawa, and Harold Johnson.

Two films were shown at the conclusion of the business meeting: G-E's *Jet Propulsion* and a private movie of the Cleveland Air Races donated by E. V. Reeves, President, National Soaring Society.

Toronto Section

Frank Brame, *Secretary*

Dr. C. C. Furnas, Director, Cornell Aeronautical Laboratory, spoke before 200 persons attending the December 1 meeting on the subject of "Future Trends in Aviation."

ARMSTRONG SWORN IN AS SURGEON GENERAL

Major Gen. Henry G. Armstrong, F.I.A.S. (left), being sworn in as Surgeon General of the U.S. Air Force Medical Service early last December by Air Force Advocate General, Major Gen. Reginald C. Harmon as Chief of Staff, Gen. Hoyt S. Vandenberg, looks on. General Armstrong, an authority on aviation medicine and a winner of the Collier Award for aviation achievement in 1939, served as Surgeon for the Eighth Air Force during the war, based in England. In 1946, he was assigned Commandant of the School of Aviation Medicine at Randolph Air Force Base, Texas, and, in July, 1949, he became Deputy Surgeon General. He succeeds Major Gen. Malcolm C. Grow, who retired on November 30.

Student Branches

Academy of Aeronautics

A business meeting was held on December 7, at which Chairman Harry W. Kirkwood presided.

Aeronautical University

On November 17, three students presented prepared talks in the I.A.S. Lecture Contest. Twenty persons attended, with Howard Walker, Chairman, presiding.

H. A. Shimer spoke on "Wind Tunnels," A. H. Meyers on "Jet Engines," and R. J. Duba on "Aircraft Fuels." The winner of the contest is to be announced to the graduating class.

University of Alabama

Two films, *Air Flow* and *Jet Propulsion*, were shown at the November 8 meeting. The first illustrated the behavior of air in motion around airfoils. The second was a Walt Disney production supplied by General Electric Company; it gave simple and clear explanation of gas-turbine power.

Brown University

Two N.A.C.A. films were shown at the December 6 meeting: *The Study of Air Flows by Means of Smoke* and *The N.A.C.A. Free-Spinning Wind Tunnel.*

Chairman Rodger B. Dowdell presided, with 30 members attending.

Carnegie Institute of Technology

Master of the Skies, a film on the high-altitude turbosupercharger, was shown at the November 15 meeting, Chairman James E. Chikar presiding. Twelve members were present.

A Program Committee was formed, and F. Dinkins and B. Rote were appointed members.

Case Institute of Technology

Following a short business meeting, a film, *The Attitude Gyro,* was shown at the November 22 meeting. The film illustrated the principles and operation of the attitude gyro, a device indicating to the pilot the plane's attitude in all maneuvers.

Chairman Raymond S. Wagner presided with 15 members attending.

Catholic University of America

On November 16, 50 members heard Commander Thomas F. Connally, U.S.N., Director of Test Pilot Training, Patuxent Naval Air Station, give a talk on "Flight Testing of Naval Aircraft." Chairman Woodrow Seamone presided.

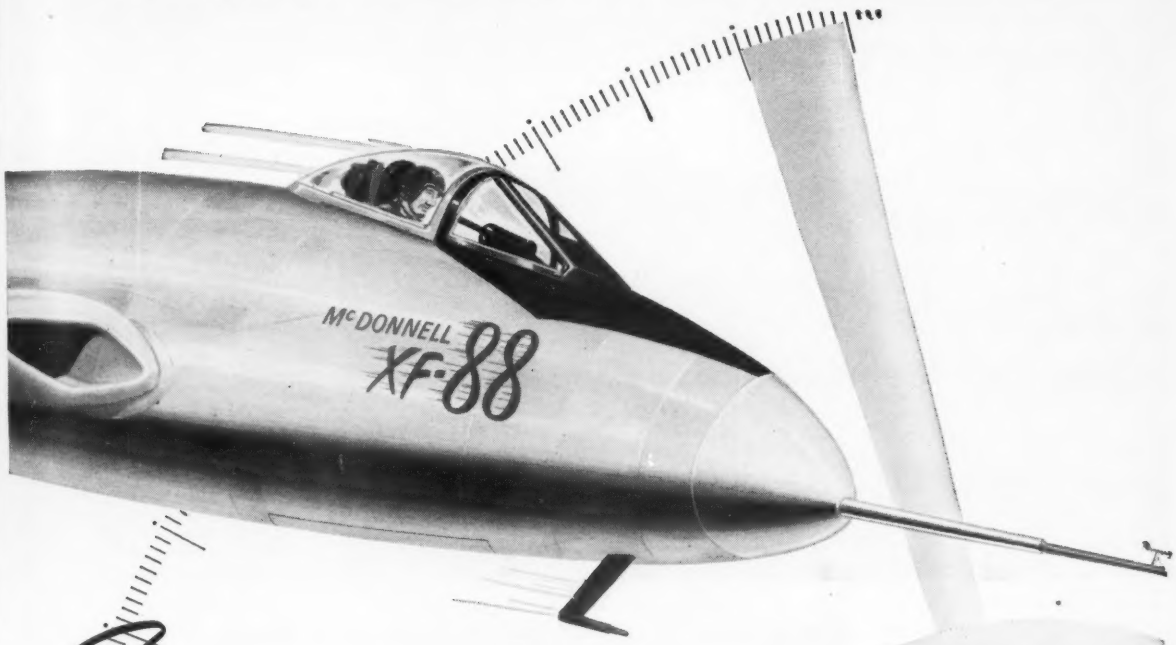
The Commander outlined the procedure of testing naval aircraft, which, he said, is not the glamorous profession that films have sometimes indicated, but one that entails hard work and long hours of study on the ground before the pilot climbs into the cockpit to take off.

The test pilot, said Commander Connally, starts studying the airplane when it is in the design stage and is kept informed of any design changes by the contractor. Upon delivery of the plane, the test pilot closely checks the aircraft on specifications of cockpit arrangement, equipment, armament, safety devices, instrumentation, and numerous other factors. The plane also is weighed to determine the center of gravity.

At the conclusion of the talk, the Commander was presented with an engraved cigarette lighter by Mr. Seamone.

Two Technicolor films were shown: the G-E *Jet Propulsion* and a film on *North American Aviation Developments.*

(*Continued on page 86*)



Split second performance requires hair-trigger operation!

As the speeds of aircraft have gone up and up and up . . . as the complexities of aircraft have thrown additional burdens upon the pilot, the need for mechanical control has become more essential. Many of the nation's manufacturers of aircraft have called on Foote Bros. to produce units such as landing gear actuators, speed brake actuators, jet engine accessory drives and rotor drives.

These units must meet extremely rigid specifications. They are required to fit a confined space envelope. High speeds call for the utmost in precision. Minimum weight is of greatest importance.

Foote Bros. aircraft devices and Foote Bros. precision gears are engineered and produced to meet these exacting specifications and are serving on such famous aircraft as the McDonnell XF-88 and Banshee, the Boeing B-50 and B-47, the Piasecki Helicopter, the Convair B-36, the Lockheed Constellation and many others.

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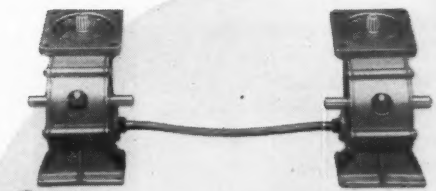
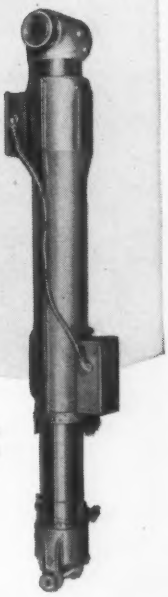


Speed brake system engineered and produced by Foote Bros. for the McDonnell XF-88

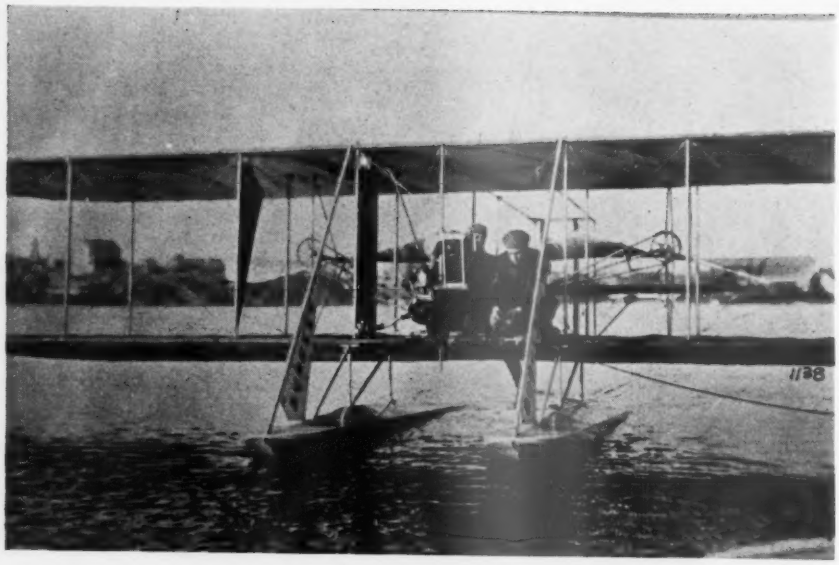
Main rotor drive built by Foote Bros. for the Piasecki Helicopter.



Landing gear actuators on the Boeing B-47, B-50 and C-97—a product of Foote Bros.

FOOTE BROS.

Better Power Transmission Through Better Gears



1912

As a part of an M.I.T. thesis on the thrust of airplane propellers, Luis de Florez learned to fly this Wright-type Burgess-built seaplane in the summer of 1912.

1949

(Above) The Admiral compares a model of the Phantom with other aircraft of the 1912 era in the Institute's Museum. *(Right)* What he thinks of jet flying is evident in this Navy picture taken immediately after his first landing in the Phantom at Floyd Bennett Field.

Editorial

In One Pilot's Lifetime

Not so long ago (December 8, to be exact), Luis de Florez dropped in, boiling with greater-than-average enthusiasm—which, for the Admiral, means a fairly high temperature. He had checked out on the McDonnell Phantom at Floyd Bennett Field the evening before and that afternoon had added several hours of jet flying to his long and distinguished piloting record.

The thing that caught our fancy, however, was the Admiral's remark that he had first learned to fly on a Wright-type pusher biplane (a Burgess) in 1912. That is a record that few (if any) pilots could match. Most of the real Early Birds are now too far along to be able even to climb into a jet fighter, to say nothing of flying it. Apart from demonstrating the well-known de Florez dexterity with aircraft, the event pointed up dramatically how far we have come in a few brief years.

Take a look at a model of the Wright or Curtiss machines of 38 years ago and then look at any modern jet fighter. Except that they are both air-borne machines, they bear little external, and virtually no internal, resemblances to each other. From a haphazard collection of sticks and wires of completely unpredictable performance to a highly dependable machine capable of combat at near supersonic speeds, all within the active piloting lifetime of one man, is a rather staggering achievement. Most important, these remarkable changes did not take place by slow, hit-or-miss processes of evolution. They came about through intensive application of research results to aircraft development problems by first-rate engineers. Many members of the Institute have played leading parts in bringing such things to pass, and today we are all straining forward toward even greater things for the future.

As we all know, the era of cut-and-try and of invention by inspiration is long since over. Aeronautical advance now depends more on effective teamwork of large groups than upon the single-handed contribution of the individual. Although in the past we have gone ahead with remarkable speed, as Luis de Florez has demonstrated, the "team concept" has greatly accelerated our rate of advance. Although the going gets tougher as we progress—who knows, we may yet find an "Early Bird" at the controls of the first rocket to the moon!

S. P. J.

Eye Movements of Aircraft Pilots During Instrument-Landing Approaches

PAUL M. FITTS,* RICHARD E. JONES,† and JOHN L. MILTON‡

Air Materiel Command

Why Information Is Needed on How Pilots Use Their Eyes

Information about how pilots use their eyes while flying "on instruments" is fundamental to a basic understanding of the functions served by aircraft instruments and to simplification of the psychological processes that occur while a pilot is controlling an aircraft's altitude, location, and rates of movement in three-dimensional space. If we know where a pilot is looking we do not necessarily know what he is thinking, but we know something of what he is thinking about. In servo terminology, we know what error signal inputs he is operating on.

Investigations of pilots' eye movements were initiated early in 1947 by the Psychology Branch of the Aero Medical Laboratory, U.S.A.F. Air Materiel Command. The purpose of the studies was to obtain answers to such questions as the following: Do pilots observe more than one instrument "at a glance," or do they always look directly at specific instruments, one at a time? Are some instruments checked much more often than others? Do some instruments require much longer to check than others?

It was believed that answers to these questions would help to solve problems that arise in designing instruments that are easy to read and in arranging these instruments into functional groupings on the instrument panel.

The Technique Employed in Recording and Analyzing Eye Fixations

To obtain reliable objective data on how pilots use their eyes during instrument flight, it was necessary to devise a recording technique that could be employed without disturbing the pilot's normal fixation and movement patterns. In a wartime study, McGehee[1] installed a camera behind the instrument panel and obtained direct photographs of pilots' eyes. A modification of this procedure was used in the present studies. A 35-mm. motion-picture camera was installed behind and to the side of the pilot, and photographs were made of his eyes as they were reflected in a small rectangular mirror placed in the center of the instrument panel. The instrument panel and camera arrangements are shown in Figs. 1 and 2. Pilots wore a translucent hood that prevented all vision outside the cockpit but permitted an unrestricted view of the instrument panel. This hood cut out very little of the light that fell on the pilot's face, and gave the camera a clear "look" at his eyes.

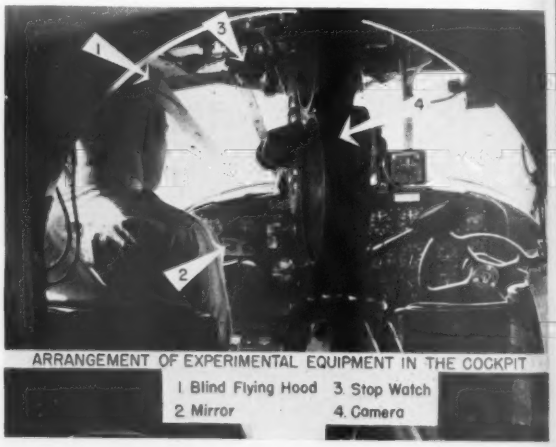


Fig. 1.

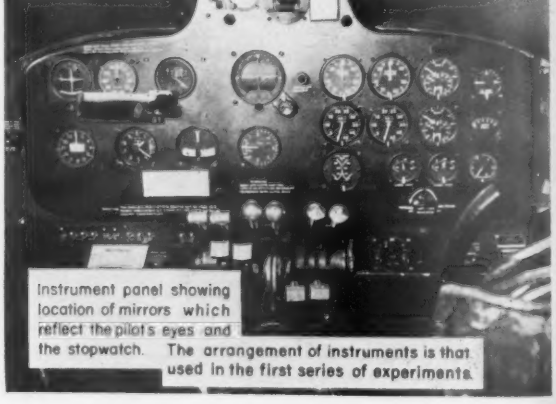

Instrument panel showing location of mirrors which reflect the pilot's eyes and the stopwatch. The arrangement of instruments is that used in the first series of experiments.

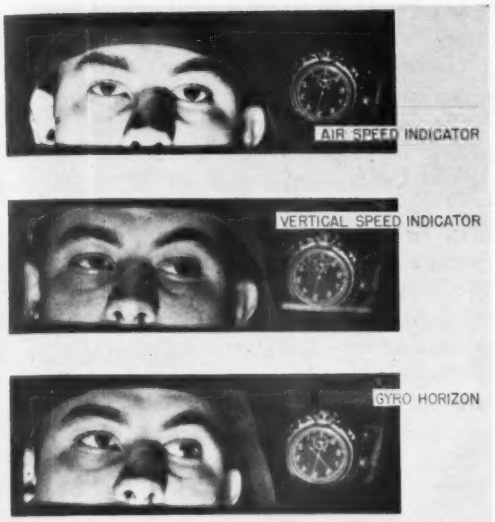
Fig. 2.

Presented at the Human Engineering in Aviation Session, Seventeenth Annual Meeting, I.A.S., New York City, January 24–27, 1949. The research reported here was done jointly by the three authors. It is reported more completely in *U.S.A.F. Air Materiel Command Technical Reports Nos. 5837, 5839,* and *5840.*

* Ph.D., Professor of Psychology and Director, Aviation Psychology Laboratory, The Ohio State University; formerly Chief, Psychology Branch, Aero Medical Laboratory, U.S.A.F. Air Materiel Command.

† Captain, U.S.A.F., Psychology Branch, Aero Medical Laboratory.

‡ First Lieutenant, U.S.A.F., Psychology Branch, Aero Medical Laboratory.



Three frames of photography reproduced from the film recording of one subject's eye movements to illustrate the ease with which the instrument the pilot is fixating can be determined.

FIG 3.

The 40 Air Force pilots who served as subjects in the first investigation ranged in age from 23 to 37 years with a median of 27 years. Their total flying time ranged from 700 to 5,000 hours with a median of 2,000 hours. Their median instrument time was 200 hours. Half of the group were instrument flight instructors or pilots who had been engaged in frequent instrument flying.

At the beginning of each flight, standard reference photographs were taken with the pilot looking directly at each instrument. These reference photographs were made into slides that were used as "measuring samples" in scoring the experimental records. Three of these reference photographs are reproduced in Fig. 3.

Film records were analyzed frame by frame in a Moviola viewer. Doubtful frames were checked against the reference photographs. The time spent in looking at each instrument was determined from a stop watch that appeared in each frame of photography. All films were read twice by different readers. The resulting data, which are reported in the present paper, are based on 160 min. of recording on 40 different pilots during 160 approaches for a landing under simulated instrument conditions, or on 76,800 frames of photography.

FLIGHT PROCEDURES IN RECORDING GCA AND ILAS APPROACHES

All experimental flights were made in a C-45 aircraft that was equipped with standard instruments and the standard panel shown in Fig. 2. The aircraft was provided by the Air Materiel Command's Flight Test Division. Instrument pilot schools at Barksdale Air Force Base, Wright-Patterson Air Force Base, and the Air Materiel Command's All Weather Flying Division assisted in the project. Two 30-sec. eye-movement records were obtained on each of the 40 pilots during each of two approaches made with the Instrument Low Approach System (ILAS) and during each of two approaches made with the radar Ground Controlled Approach (GCA) system.

ILAS and GCA are the two low-approach systems now in general use. When flying the ILAS system, the pilot depends entirely upon his instruments. One of these, the cross pointer, presents information that tells him how far he is deviating in azimuth and altitude from a desired flight path that terminates at a point on the runway where he should land. By cross-checking the cross pointer with the directional gyro, he can determine what heading to fly. When flying the GCA system, the pilot uses only the standard instruments employed in cross-country flying. He receives, by radio, oral direction from a ground radar station about the heading that he should hold and the corrections that he should make in rate of descent in order to maintain a flight path that will terminate at the point on the runway where he wants to land.

During the experimental flights, the recording camera was started as the aircraft passed over the outer marker beacon at approximately $4\frac{1}{2}$ miles, or slightly more than 2 min., from the touch-down point. At the end of 30 sec. it was turned off. A second record was begun as the aircraft passed over the middle marker beacon at approximately $1\frac{1}{2}$ miles from the touch-down point and at about 300-ft. altitude. This recording also lasted for 30 sec. At that time, the safety pilot took over and initiated a go-around procedure. One half of the pilots made ILAS approaches first, and one half made GCA approaches first. Photographs were taken at the rate of 8 frames per sec.

Eye movements have also been recorded during maneuvers at altitude, during straight and level flight, during contact take-offs and landings, and during night flights. Results from these additional studies are now reported in the present paper.

RESULTS

It was found, as had been expected from what is already known about eye movements, that pilots look directly at each instrument for an appreciable period of time and then shift their eyes quickly to another instrument. Including all fixations for all pilots, the average time per eye fixation was slightly more than 0.6 sec. The eyes are actually in motion a relatively small proportion of the time. Only 3 per cent of film exposures showed the eyes to be blinking, to be blurred because they were in motion, or to be in a position that was different from both the preceding and following positions; therefore, it can be concluded that the eyes are fixating on specific instruments at least 97 per cent of the time during instrument flight. Eye movements to the left and to the right occurred equally often. In other

TABLE 1

Mean Frequency of Checking Different Instruments During Instrument Low Approaches (N = 40 Pilots)

	Number of Fixation Cycles* Per Minute			
	ILAS		GCA	
Instrument	Mean	Root Mean Square	Mean	Root Mean Square
Cross pointer	29.6	6.30		
Air speed	16.0	3.04	18.2	8.02
Directional gyro	28.0	9.06	33.2	7.94
Gyro horizon	16.9	9.12	20.6	9.46
Altimeter	2.7	1.86	4.6	3.38
Turn and bank	0.9	1.03	3.2	4.74
Rate of climb	3.5	3.04	6.2	5.72
Engine panel	1.7	1.58	2.6	2.34
Mean fixations per min.†	106.0	19.56	93.0	18.68

* A fixation cycle is here defined as the time spent in moving the eyes to an instrument and in looking continuously at that instrument. It may include several fixations on different parts of the instrument and it may occasionally include an eye blink.

† This figure is based on all frames of photography, including eye blinks, looking around the cockpit, etc.

TABLE 2

Mean Duration of Eye-Fixations on Different Instruments During Instrument Low Approaches (N = 40 Pilots)

	Length of Fixation Cycle in Seconds			
	ILAS		GCA	
Instrument	Mean	Root Mean Square	Mean	Root Mean Square
Cross pointer	0.86	0.31		
Air speed	0.38	0.09	0.57	0.17
Directional gyro	0.56	0.08	0.90	0.26
Gyro horizon	0.54	0.13	0.56	0.21
Altimeter	0.38	0.11	0.39	0.11
Turn and bank	0.34	0.13	0.36	0.16
Rate of climb	0.39	0.12	0.47	0.12
Engine panel	0.71	0.34	0.88	0.31
Mean duration of fixations*	0.59	0.12	0.67	0.14

* This figure is based on all frames of photography.

words, there was no tendency, as there is in reading, to make many short movements to the right and a few long movements to the left.

Three types of data are available for each instrument: (1) mean "fixation cycle" time, the time required to move the eyes to an instrument and then check it; (2) mean number of fixations per instrument per min.; and (3) eye-movement link values between each pair of instruments, indicating the relative frequency of eye movements from each instrument to every other instrument. Data for ILAS approaches are given in Tables 1 and 2 and in Figs. 4 and 5. Data for GCA approaches are given in the same tables and in Figs. 6 and 7. These data will be considered for each low-approach system separately.

Instrument Low-Approach System (ILAS)

The average number of fixations per min. on each of the instruments varied from 30 on the cross pointer to 1 on the turn and bank indicator. By multiplying the number of fixations by the length of the fixation cycle, it is possible to determine the proportion of time devoted to each instrument. It should be noted that two-thirds of all the time available to pilots during ILAS approaches was spent in observing two instruments, the cross pointer and the directional gyro or heading indicator.

Knowing the frequency with which these pilots obtained error information from different instruments, it can be concluded that they checked their position on the glide-path localizer beam about every 2 sec., their heading about every 2 sec., their air speed approximately every 4 sec., and other indications only 2 or 3 times per min. In terms of distance traveled at a standard approach speed of 120 m.p.h. (176 ft. per sec.), these pilots traveled a minimum of 350 ft. between the time any flight instrument was checked and the time it was checked again. This figure indicates the extent of pilot lag in detecting deviations from the desired flight path and throws light on the instability problem encountered during instrument approaches.

In Fig. 5 are shown the frequencies of eye movements between instruments during ILAS approaches. Eye movements in both directions between instruments have been combined. The *largest* link value, accounting for 29 per cent of all eye movements, was between the cross pointer and the directional gyro. The *longest* important link was between the cross pointer and the gyro horizon. Placement of the most frequently used instrument, the cross pointer, at the extreme left, was obviously a poor arrangement for ILAS landings.

Ground Control Approach (GCA)

The GCA data, like those for ILAS, are based on 2 min. of records on each of 40 pilots. The number of fixations per min. was found to vary from 33 on the heading indicator to 3 on the turn and bank indicator and 3 on the engine instruments. The length of fixation cycle varied from 0.90 sec. on the heading indicator to 0.36 sec. on the turn and bank indicator. During a GCA landing, 49 per cent of the total available time was spent in checking heading.

It is interesting to note how the time that was spent in looking at the cross pointer during an ILAS approach was distributed during a GCA approach. Fixations on all instruments were longer—the time for an average fixation cycle increased from 0.59 to 0.67 sec. The average fixation time for the more important instruments increased as follows: the air speed indicator, from 0.38 to 0.57 sec.; the directional gyro, from 0.56 to 0.90 sec., and the gyro horizon from 0.54 to 0.56 sec. In addition, all of the instruments were checked more often. In general, however, the seven instruments that were common to the two systems maintained relatively the same standing with respect to each other as regards frequency of use and fixation time.

In Fig. 7 are shown the link values for GCA approaches. The arrangement used appears to be an efficient one. The two most important links, accounting between them for 57 per cent of all eye movements, are short horizontal ones between the directional gyro and the air-speed indicator, and between the directional gyro and the gyro horizon. The instrument that is used most was located in the favored position—i.e., in

LENGTH OF EYE FIXATIONS AND NUMBER OF FIXATIONS ON AIR-CRAFT INSTRUMENTS DURING I LAS APPROACHES

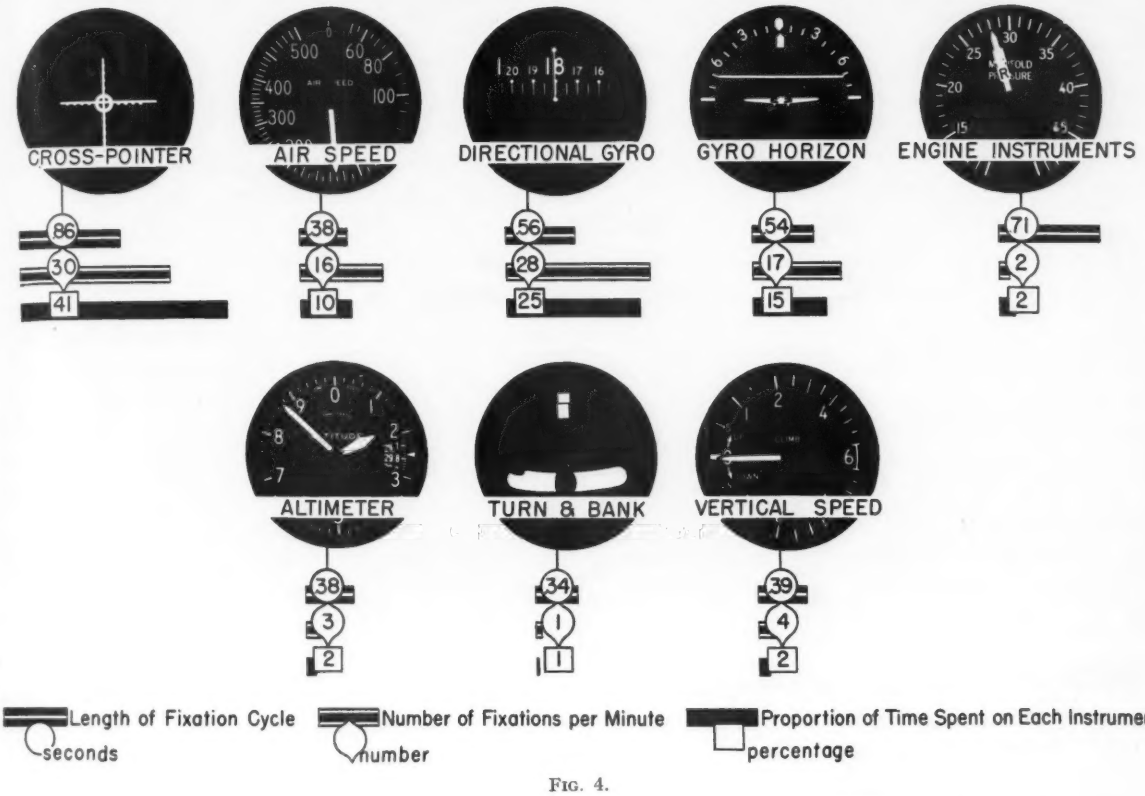
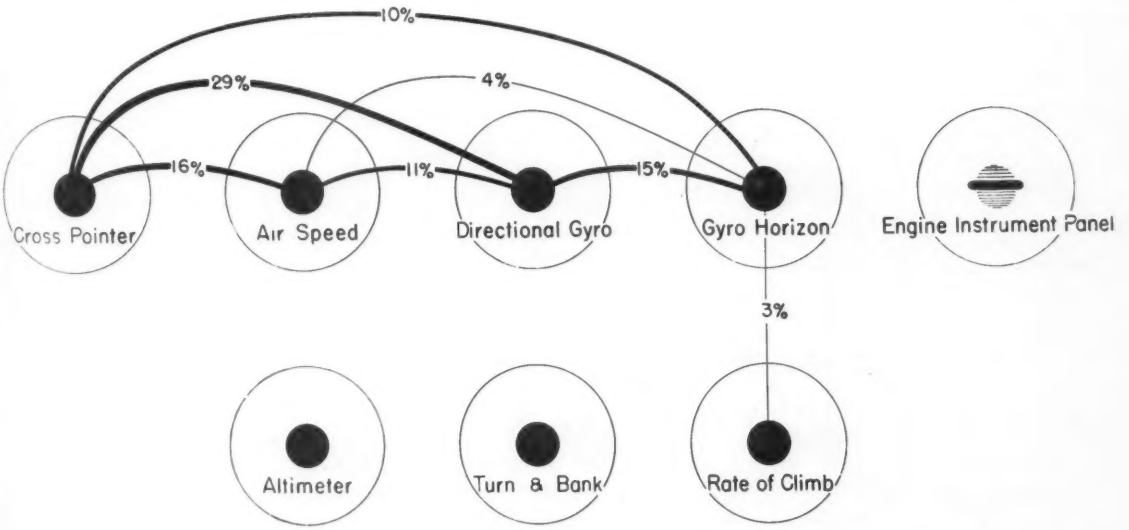


FIG. 4.

EYE MOVEMENT LINK VALUES BETWEEN AIRCRAFT INSTRUMENTS

INSTRUMENT LANDING APPROACH SYSTEM (I.L.A.S)



LINK VALUES BASED ON 40 PILOTS — VALUES LESS THAN 2% OMITTED

FIG. 5.

LENGTH OF EYE FIXATIONS AND NUMBER OF FIXATIONS ON AIRCRAFT INSTRUMENTS DURING G.C.A. APPROACHES

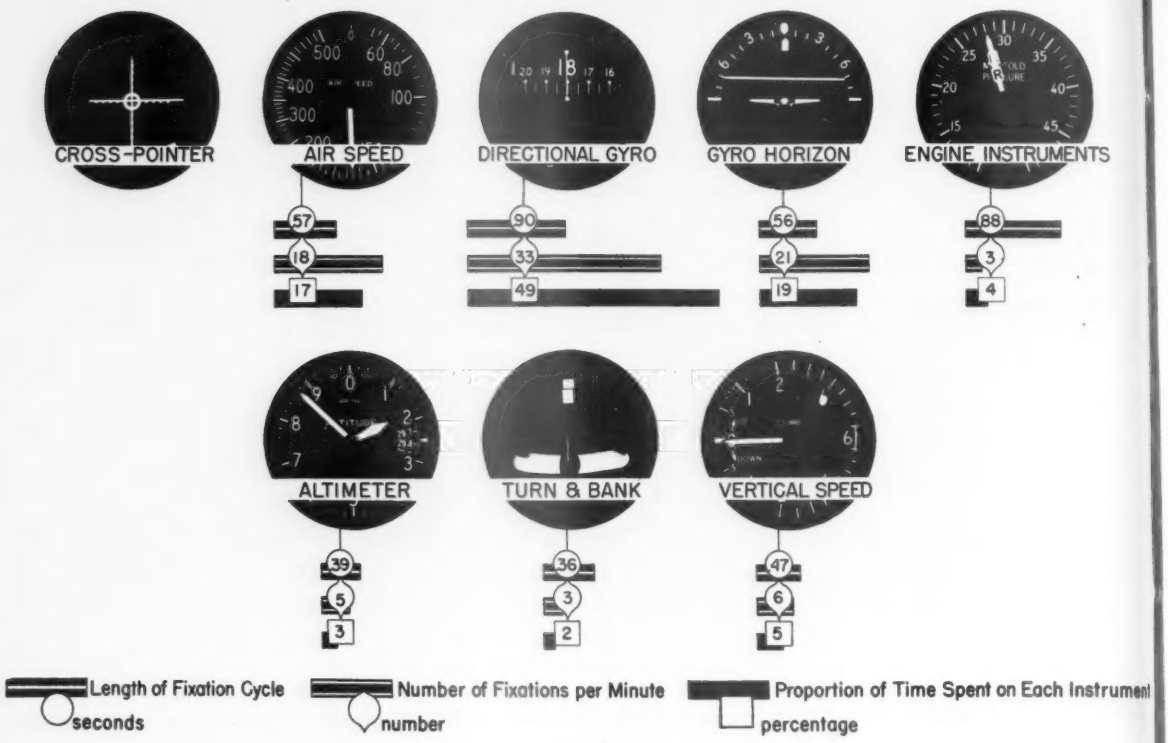


FIG. 6.

EYE MOVEMENT LINK VALUES BETWEEN AIRCRAFT INSTRUMENTS
GROUND CONTROL APPROACH
G.C.A.

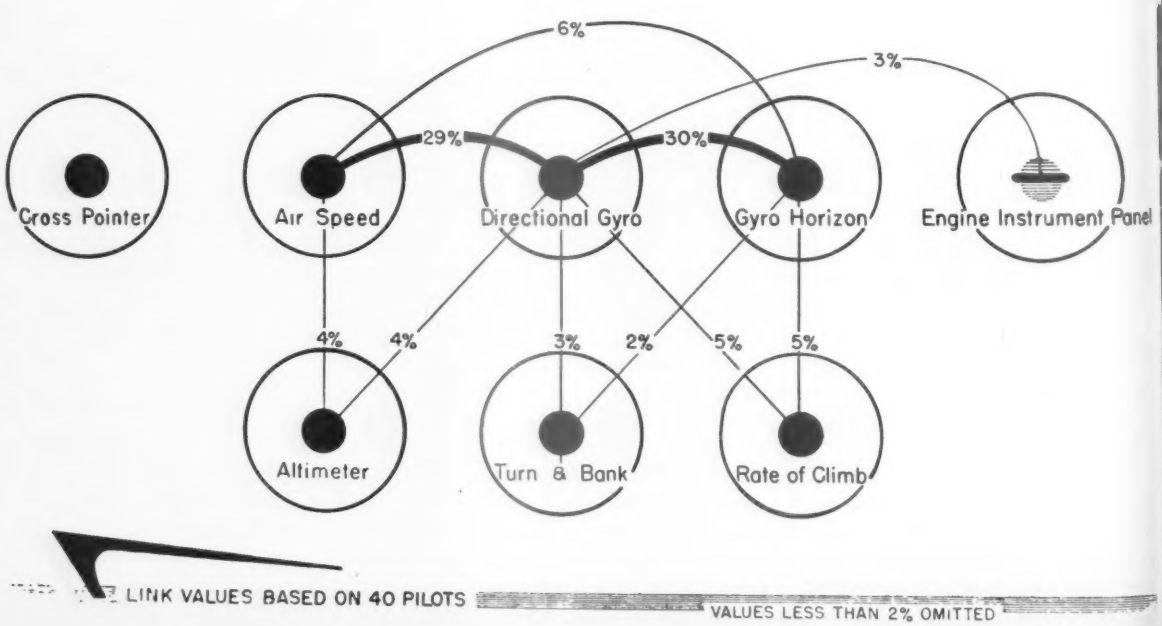


FIG. 7.

the center of the top row. Little or no improvement in this arrangement for GCA landings can be suggested as far as these specific instruments and this particular aircraft is concerned.

Individual Differences Among Pilots

To examine the range of eye-movement differences between pilots during ILAS approaches, we can compare the pilot who made the most fixations per min., whom we shall call Pilot A, with the pilot who made the fewest fixations per min., Pilot B. Pilot A averaged 154 fixations per min., or 0.4 sec. per fixation. Pilot B averaged only 65 fixations per min. or almost 1 sec. per fixation. Pilot A made 46 fixations on the cross pointer and required only 0.4 sec. for each check, while Pilot B made 29 fixations on the cross pointer and required 1.4 sec. for each check.

Other striking differences were found between pilots. For example, Pilot C required an average of 2.2 sec. to check the cross pointer or over five times as long as Pilot A. Pilot B used the artificial horizon practically not at all during ILAS work, while Pilot D made 41 out of a total of 140 fixations per min. on this instrument.

The relation between total flying time and eye-movement characteristics during ILAS approaches, as reflected by the correlation between these two measures on the 40 pilots, was generally low (Table 3). Similarly, there were no very striking differences between the eye movements of pilots with different amounts of instrument time. More experienced instrument pilots tended to make slightly more use of heading (directional gyro) and glide-path and localizer (cross-pointer) information; to make less use of the turn and bank indicator, the engine instruments, and the air-speed indicator; and to make somewhat shorter fixations on all instruments.

The range of individual differences between these pilots is not quite as pronounced during GCA approaches as it is during ILAS approaches. The number of fixations per min. varied from 59 to 129. In general, pilots who made a large number of rapid fixations when flying one system also made a large number of rapid fixations when flying the other system. The correlation coefficient for number of fixations per min. on GCA with the number of fixations per minute on ILAS is 0.62.

TABLE 3

The Relation Between Total Flying Time and Eye-Movement Measures Made During ILAS Approaches (N = 40 Pilots)

Instrument	Correlation Coefficients for Total Flying Time vs. No. of Fixations per Min.*	Duration of Fixation Cycle†
Cross pointer	0.20	−0.26
Air-speed indicator	−0.27	−0.37
Directional gyro	0.02	−0.14
Gyro horizon	0.35	0.09
Altimeter	−0.01	−0.26
Turn and bank indicator	−0.24	0.03
Rate-of-climb indicator	0.18	−0.25
Engine-instrument panel	−0.04	0.12
Total fixations (all instruments)	0.35‡	−0.30

* A positive correlation indicates that more experienced pilots checked an instrument more often; a negative correlation, that they checked it less often.

† A positive correlation indicates that more experienced pilots made longer fixations; a negative correlation, that they made shorter fixations.

‡ Significant at the 5 per cent level of confidence.

SUMMARY AND DISCUSSION

It is reasonable to assume that *frequency* of eye fixations on any given instrument is an indication of the relative *importance* of that instrument. The *length* of fixations, on the contrary, may more properly be considered as an indication of the relative *difficulty* of checking and interpreting particular instruments. The *pattern* of eye movements—i.e., the link values between instruments—is a direct indication of the goodness of different panel *arrangements*.

The technique of eye-movement recording offers an effective method of evaluating new types of instrument displays from these three points of view—importance, ease of interpretation, and panel arrangement. It has been discovered that eye movements vary from pilot to pilot, from maneuver to maneuver, and from instrument to instrument. It is likely that similar differences will be found for different aircraft, for different panel arrangements, for day vs. night flying, and for different designs of the same instrument. Several of these factors are now under investigation. Final results should contribute a great deal to a basic understanding of instrument-reading problems and to the design of better instruments and better instrument-panel arrangements.

The following points briefly summarize the findings reported in the present paper:

1. Forty pilots were found to make an average of 106 eye fixations per min. during ILAS approaches (0.59 sec. per fixation) and an average of 93 eye fixations per min. during GCA approaches (0.67 sec. per fixation).

2. Different instruments among the basic flight group were checked with very different frequencies. These differences were greater than ten to one.

3. Different instruments among the basic flight group required very different lengths of time to check. These differences were greater than two to one.

4. There was marked variability between pilots in eye-movement characteristics. There was a slight tendency for more experienced pilots to make shorter fixations.

5. It is concluded that the eye-movement recording technique offers a valuable method of evaluating new instruments with respect to (a) importance, (b) ease of interpretation, and (c) panel arrangement.

REFERENCE

[1] McGehee, W., *Comparative Study of Pilot Fatigue Resulting From Extended Instrument Flight Using the Standard AAF and British Instrument Panels*, Unpublished Report From the Bureau of Medicine and Surgery, U.S. Navy.

Integrally Stiffened Structures

PAUL SANDORFF* AND G. W. PAPENt

Lockheed Aircraft Corporation

ABSTRACT

In integrally stiffened structure, the skin and the skin stiffeners forming the structural surfaces of conventional aircraft are made as one part instead of being assembled from many individual elements. This method of construction indicates excellent possibilities for reducing production costs and improving structural efficiency.

Several methods are available for manufacturing large integrally stiffened surface panels, for example: extrusion, forging, rolling, casting, machining from plate, etc. This paper describes the various methods and the recent advances that have been made in developing them for the production of integrally stiffened sheet. Also presented are the results of design investigations leading to cost analyses and to the construction of sample parts. The advantages, limitations, and potentialities of each method are discussed.

INTRODUCTION

Description of Integrally Stiffened Structure

THE NEED FOR REDUCED PRODUCTION COSTS and increased structural efficiency in aircraft construction has led to the investigation and development of large sections of integrally stiffened surface structure in place of the usual multipiece skin-and-stiffener structure.

The name "integrally stiffened structure" is applied to construction in which the skin and skin-stiffening elements are made of one part. This is in contrast with conventional structure, which is built up of many individual fabricated sheet-metal parts held together by a multitude of attachments. There are several methods of making integrally stiffened structure: It may be machined from plate or billet, or it may be forged, or rolled as a sheet product, or extruded, or cast—or a combination of these processes may be used.

The immediate advantages of such a structure are the reduction in number of parts and attachments and the reduction in handling expenses and assembly tooling. Other advantages also are generally obtained, such as reduced weight, improved surface smoothness, and simplified sealing.

Functional Aspects of Aircraft Structure

Aircraft surface structure must conform to contour, shape, and clearance requirements while supporting specified loads. Generally, these loads include normal pressure or air loads, overall bending (wing or fuselage bending), which causes axial stresses in the surface elements, and overall torsion, which places shear in the skin.

Conventional skin-stressed structure has been developed to meet these requirements with high efficiency in terms of weight. Essentially such structure consists of: (1) the external sheet or skin; (2) a system of stiffeners that rigidize the skin locally and, together with the skin, carry the major surface stresses; (3) a system of regularly spaced internal supports that establish the column length or the bending length of the skin-and-stiffener combination and also transfer shear load; and (4) still another system of elements perpendicular to the last (that is, parallel to the skin stiffeners) whose purpose is chiefly to preserve shape or carry beam shear. Generally there is a taper in size and strength of all elements along the length of the assembly.

Inherent Disadvantages of Conventional Construction

Conventional construction methods leave much to be desired toward satisfying the functional, structural, and manufacturing requirements. For instance, production consists of fabrication of many individual parts, extensive subassembly, and the attachment of many structural elements running at right angles to each other, which require clips, cutouts, joggles, and discontinuities. Skin and stiffener sections are tapered by reduction in gage, requiring splices and joints. Doublers and reinforcements are necessary for structural efficiency, and weight is determined by compromise with production. Aerodynamic smoothness requirements are difficult to meet, skin surfaces often lack local rigidity, and costly tooling and special techniques are necessary. The airplane is a product of severe compromises, which leave all parties unsatisfied, even when the best available solution is found to the problems of function vs. cost.

Recent Developments in Solving the Problems

Engineers in practically every aircraft plant and the military air forces have been working on various means of solving these problems. Among the more outstanding developments are:

Tapered Sheet.—The Air Force is sponsoring a program for the development of commercial methods of producing tapered sheet at the rolling mill. Experimental quantities may be obtained today from commercial sources. Several machine shops are now specializing in the production of tapered sheet by machining from plate.

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* Group Engineer—Research.

† Group Engineer—Production Design.

Tapered Extrusion.—While not as important from a weight saving or general design viewpoint, tapered extrusion offers tremendous possibilities in material conservation. It reduces machining, and, in some instances, reduces the number of splices and parts required for section taper of stiffeners and beam caps.

Tailored Sheet.—An effort to obtain the weight advantages of tapered sheet with the reduction in number of parts available by incorporating doublers and other minor section changes with the skin is made through the so-called "tailored sheet." Some aircraft companies are setting up machines for producing this type of element, and there are several machine shops specializing in this type of machining.

Integrally Stiffened Structure.—Each of the previous developments attacks only a small phase of the problem. Integrally stiffened structure attacks all phases. It combines the advantages of "tailored sheet" with integral stiffeners, thus further reducing the number of parts, number of attachments, and number of splices and joints. Fig. 1a illustrates the number of parts required to produce a tank panel by conventional construction. Fig. 1b is the integrally stiffened-structure answer to the same design requirement.

Machining

Machining from plate or billet is the only method immediately available for producing integrally stiffened sheet of satisfactory structural properties.

Machining has the advantage of great flexibility in design. High-speed equipment and methods now used extensively in milling aircraft parts have greatly increased the practicality and potentialities of machining as a primary method of fabrication. In addition, it may be used to duplicate any other type of integral stiffening for experimental study or for prototype construction, and, when extruded and forged integrally stiffened designs become available, it may be desirable to apply the same machining methods to reduce skin thicknesses and to incorporate taper, local trim, and reinforcement pads. The great disadvantage of machining from plate is that too large a percentage of the raw material is wasted in chips.

End Milling

The most readily applied method of machining integrally stiffened sheet is that of end-milling (axis of the cutting tool perpendicular to the machined surface).

No elaborate equipment is required. Fig. 2 shows a machined bulkhead rib for an integral fuel tank. This was cut from $^7/_8$-in. plate on a small Milwaukee milling machine with standard cutters and accepted methods. The finished part is equivalent to a 13-piece assembly in conventional construction. By using equipment especially adapted for such work, such as high-speed cutting heads and special beds, the machining time can be considerably reduced.

Fig. 3 shows an experimental leading-edge structure, equivalent to that used on the Constellation

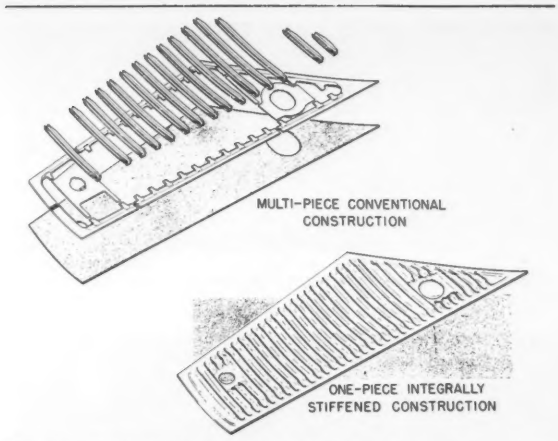

FIG. 1. Typical wing panel for high-speed aircraft: conventional vs. integral stiffening.

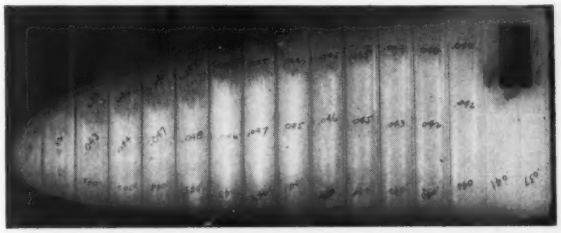

FIG. 2. Experimental bulkhead rib: web, stiffeners, flanges, and doubler pad machined integrally.

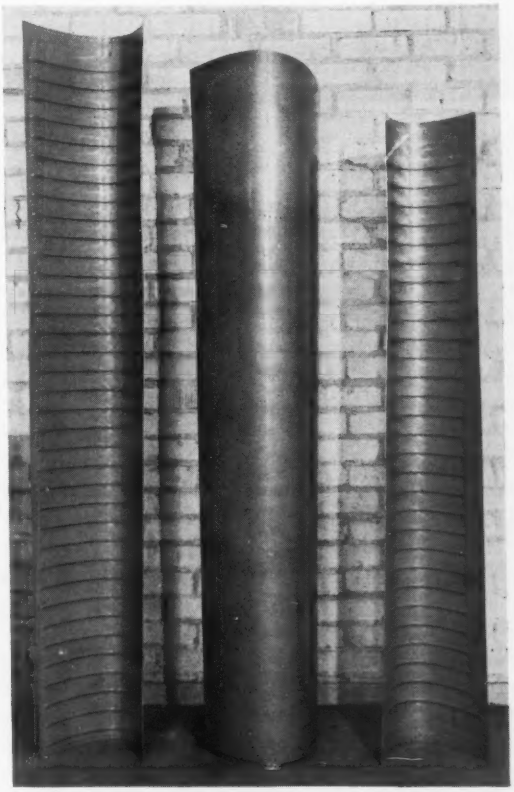

FIG. 3. Finished leading-edge panels machined from $^1/_4$-in. plate and formed to contour.

FIG. 4. Machined wing-surface panels ready for assembly.

FIG. 5. Lower surface structure of machined outer wing in assembly jig.

outer wing, which was machined from $^1/_4$-in. plate. These parts were made on a Cincinnati Hydrotel milling machine. The skin is of 0.040-in. nominal thickness, and all edges incorporate an integral doubler pad 0.072 in. thick to simplify attachment. Forming to the curvature shown was accomplished after machining by repeated bumping on a power brake; rolling has also been used to form such sections.

Slab Milling

For rapid removal of a large mass of metal, slab-milling is much better suited than fly-cutting or end-milling. The advantages are apparent chiefly for quantity production because heavier equipment and higher horsepower are required and the process is generally less flexible in application.

For the machining of integrally stiffened surfaces, Onsrud spar-milling equipment has been applied with excellent results. Typical surface panels with integral doublers and attachment pads which were machined on the Onsrud spar mill from $^7/_8$-in. plate are shown in Fig. 4. The skin thickness of the finished parts tapers from 0.091 to 0.045 in. The depth of cut is cam-guided and is accurate to within a few thousandths of an inch. Taper in skin thickness as well as local reinforcements and integral pads for end attachments are readily obtained. These panels, when assembled, form the upper surface of an experimental outer wing for the Constellation airplane. Similar construction was used in the lower surface, which is shown in the assembly jig in Fig. 5; the completed wing panel is shown in Fig. 6.

Machining to Finished Shape

The discussion thus far has been limited to the production of flat integrally stiffened panels. Most applications, however, will undoubtedly require contoured surfaces. The forming of flat integrally stiffened panels to contour poses, in some cases, production difficulties. Machining to required contour has therefore been investigated. It has also been suggested that plate of the required cross-section thickness be formed to contour and then machined to final shape. This naturally would require less machining time and would conserve material over machining from a solid

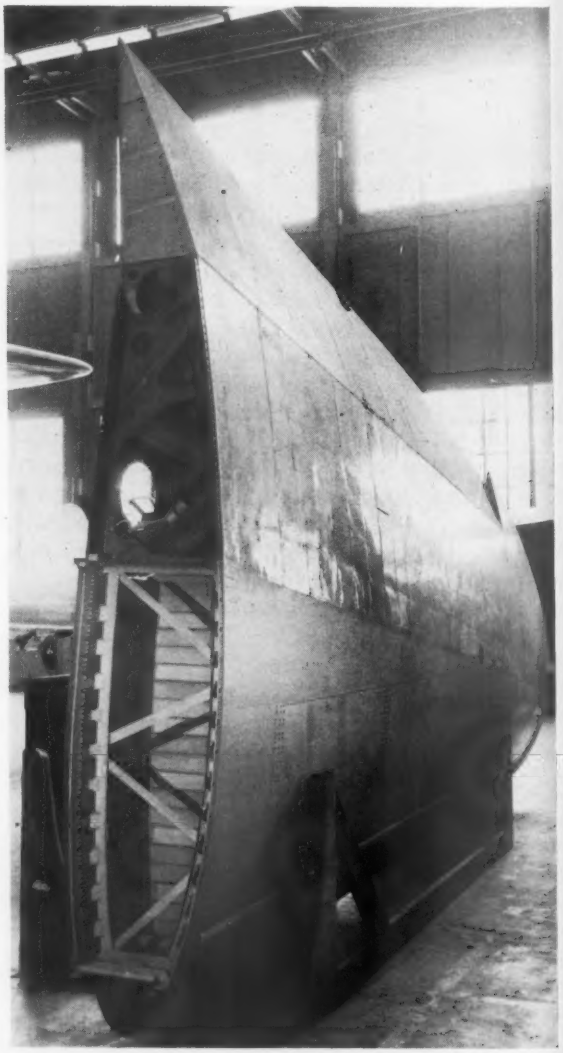

FIG. 6. Experimental outer wing: section forward of main beam made with machined integrally stiffened surfaces.

billet large enough to encompass the curvature. The type of equipment required to machine to the contoured shape must of necessity be a high-speed duplicating-type machine based on the Keller or Hydrotel principle. The best that is expected of equipment of this type is only a slight improvement on the end-mill-type operation; consequently, the machining operation would be slow and costly.

Whether or not machining from billet or rolled flat stock to the finished shape proves feasible and economical, it will probably be desirable to do some trimming and finish-machining on contoured parts. It appears feasible to forge integral panels to finished contour with subsequent machining for joints and other areas requiring closer tolerances than can be maintained by forging. It is believed that high-production equipment capable of machining a finished formed integrally stiffened part should be developed.

Typical Machined Surface Structure

The experimental wing structure described above was made interchangeable with the long-range Constellation outer wing, which serves as an integral tank carrying 550 gal. of fuel. With data obtained in the construction of this wing, a complete study was made of the value of the machining process in its present stage of development, as compared with conventional methods for producing this type of structure. The following conclusions were reached:

Structure.—The external surfaces of the machined structure are exceptionally smooth and free of rivets. No skin buckling occurs under any design load condition. All splices and bulkhead flange attachments are made with a single row of rivets through thick skin pads that are integral with the panels. On removable doors a $^1/_8$-in. thick flange is provided. There are no chordwise splices over the entire 20-ft. span. The machined taper in skin thickness and stiffener height provides optimum structural properties at all stations.

Weight.—With the machined integrally stiffened structure, a weight saving of 230 lbs. per airplane was realized. This amounted to 25 per cent of the weight of the structure subject to redesign. Half of this was due to structural weight saved by elimination of splices and by more efficient use of material; half was due to weight of fuel-tank sealing compound saved at stiffener-skin attachments.

Cost.—The approximate costs, estimated on the basis of production of fifty items, are compared in Table 1. Assembly cost—the major cost item in conventional airplane construction—is greatly reduced by integrally stiffened design. But current methods of machining, it is seen, involve increased fabrication, tooling, and material costs, which at present overbalance the saving in assembly.

TABLE 1
Cost Comparisons for Machined Structure

	Per Cent of Total Cost of Conventional Design	
	Conventional structure	Machined integrally stiffened design
Fabrication	7	17
Assembly	38	20
Tooling	21	29
Raw material	16	25
Tank sealing	18	14
Total	100	105

Future Possibilities

The data of the previous section clearly show that further development should be directed at (1) reducing raw material cost and (2) speeding up the machining process.

Reducing Cost of Raw Material.—In machining surface panels from thick aluminum-alloy plate, 80 per cent to 95 per cent of the original stock is cut away in chips and trim. Chips have low salvage value. There is, therefore, an advantage in machining from a roughly shaped section, which might be prepared, for example, by forging or extrusion.

Reducing Cost of Machining.—Machining time and cost of machining would be considerably less if equipment more suited to fabrication of surface panels were available. For example, in applying the spar-mill type of machine to quantity production, gang cutters should be used and the full width of the panel should be cut at one pass. The bed width should be increased to accommodate the largest available plate sizes, reducing overall handling time and eliminating splices. A cutter driving motor of about 500 hp., together with considerably greater machine rigidity, would be desired.

The advantages of automatic control for quantity production have only begun to be exploited. Once the work is fixed to the bed plates, all operations should be sequenced, indexed, and controlled automatically. Automatic equipment is available to some degree on milling and profiling machines in general use today.

Machining Other Types of Integrally Stiffened Sheet.—Current developmental work in the art of extrusion and forging, if carried to successful conclusion, will make available integrally stiffened shapes of much greater structural advantage than those machined from thick plate. These other types are described in later sections.

To use such extruded and forged shapes to best advantage, some machining will be necessary. Skin thickness will be reduced, stiffener sections will be sized, and tapers in thickness and depth will be incorporated, leaving doubler pads for end attachments and local reinforcements. These machining operations are similar to those used in machining plate stock, and essentially the same type of equipment is required.

ROLLED-RIBBED SHEET

Developments to Date

One of the most promising methods of making integrally stiffened sheet is by rolling stiffening ridges into the sheet stock as it is processed in the mill. The

FIG. 7. Typical sections suitable for production by rolling.

problem to date has been the determination of sizes, proportions, and materials that would be most satisfactory for structural applications and would still be reasonable to produce by rolling. Sections suitable for rolling are illustrated in Fig. 7.

Rolled-ribbed sheet is far superior in rigidity to unstiffened sheet of the same total weight. Because of limitations of the rolling operations, however, it cannot be made to compare in efficiency with a built-up skin-and-stiffener structure. Its advantages, therefore, lie only in applications where adequate skin-stiffening by ordinary methods is impossible or impractical. A large portion of the exposed surface of every airplane falls in this category—trailing-edge surfaces, fairing surfaces, cover panels, control surfaces, etc.—where applied loads are so light that skin gages are the minimum as determined by handling requirements, stiffeners are as close as production expense will allow, and surface roughness and "oilcanning" still remain a problem.

Development work on the equipment and technique of rolling ribbed-sheet stock is currently in progress at Reynolds Metals Company under a contract with U.S.A.F.

Applications

Application of rolled-ribbed sheet to aircraft structures has been under continued investigation at Lockheed, and several experimental designs have been constructed using ribbed sheet made by machining from plate.

As a result of these studies, the section shown uppermost in Fig. 7 has become standardized. This section has 0.016-in. thick skin, with integral stiffeners 0.125 in. deep at 1-in. spacing. The total weight is the same as that of plain 0.020-in. sheet, but its rigidity is more than 20 times as great. This one section, it has been found, can be applied much as ordinary sheet stock in place of the 0.016-, 0.020-, and 0.025-in. skin used in conventional designs, with reduction in parts, increase in rigidity, and possible weight saving. Several experimental applications are described below.

Aileron Tab.—An experimental tab was constructed which was identical in function and strength to the aileron tab of the Constellation airplane. The surfaces and beam of this tab were formed in one piece from simulated rolled-ribbed sheet stock as shown in Fig. 8. This skin section replaced the 0.016-in. outer skin, the 0.016-in. beaded inner skins, and the 0.032-in. beam web in the conventional design; enough weight was saved here with rolled-ribbed sheet to permit use of a casting for the central actuator fitting. Thus, considerable simplification was achieved, and it was estimated that,

FIG. 8. One-piece tab skin of rolled-ribbed sheet: formed and trimmed, before assembly.

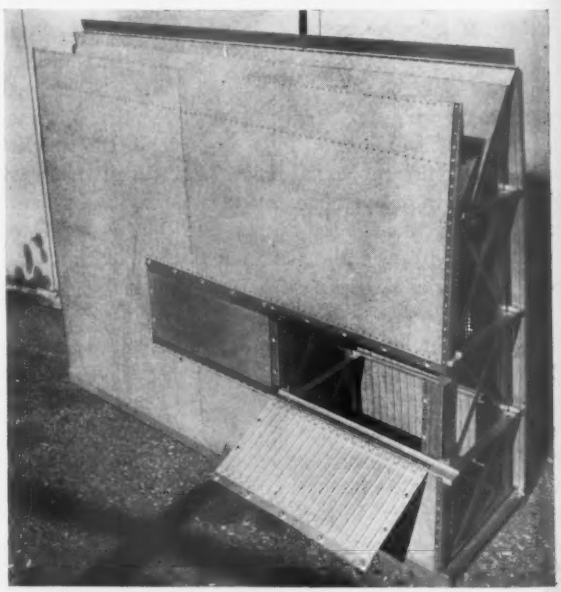

FIG. 9. Wing aft structure with rolled-ribbed skin, view of lower surface.

TABLE 2
Cost Comparisons: Rolled-Ribbed Structures

	Aileron Tab		Wing Aft Structure	
	Integrally stiffened construction	Conventional construction	Integrally stiffened construction	Conventional construction
Weight (total weight per unit)	4.65 lbs.	4.80 lbs.	28 lbs.	28 lbs.
Number of Parts				
Total number detail parts per airplane	16	64	116	152
Total number different parts per airplane	7	25	47	61
Number of Attachments				
Rivets per assembly	220	490	1,310	1,380
Spotwelds per assembly	...	560	...	2,260
Cost (based on production of 50 airplanes)				
Material	$25.02*	$ 4.57	$120.30*	$ 17.63
Labor	46.16	84.57	102.40	227.90
Tooling	58.05	112.85	79.60	123.10
	$129.23	$201.99	$302.30	$368.63

* Includes total cost of machining the integrally stiffened sheet from 0.125-in. plate stock.

even if the rolled-ribbed sheet were to be *machined* for production, a net saving could be achieved. Parts and cost comparisons are indicated in Table 2.

Wing Aft Structure.—The trailing-edge surfaces of the Constellation wing carry no wing bending loads but only the direct air loads of low magnitude which are transferred forward immediately to the main wing structure. Consequently, the aft surfaces are made as light as possible, the skin gages and stiffening being determined chiefly by handling requirements, manufacturing problems, and oilcanning tendencies. (See Fig. 6.)

An equivalent structure made with rolled-ribbed sheet is illustrated in Fig. 9. The improvement in smoothness is evident from the photographs. Only half as many ribs were required, and the necessity for contour-formed chords was eliminated. The aft beam or "false spar" was also constructed of rolled-ribbed sheet. Comparative data and cost estimates for the 60-in. section in conventional structure and as designed with rolled-ribbed skin are presented in Table 2.

Aileron Trailing Edge.—On lightly loaded trailing-edge structure, the use of rolled-ribbed sheet with stiffening elements oriented chordwise often provides sufficient rigidity and strength so that all internal framework can be eliminated. For example, the aileron trailing edge of the Constellation airplane is constructed of 0.020-in. skin supported by many light ribs spaced 4 in. apart. An alternate design was made using rolled-ribbed sheet; all ribs were eliminated, and a slight weight advantage was also obtained.

Miscellaneous.—Several other advantageous applications for rolled-ribbed sheet have been suggested: ducts, tanks, shell structures, leading-edge skins, rib webs, fairing, equipment and furnishings, instrument cases, cabinets, junction boxes, cabin partitions, doors, etc. Many suggested uses are outside the aircraft field; for example, roofing and siding, household furnishings, containers, and architectural and interior-decorating purposes.

Fabrication Techniques

No new tools or special techniques are required to use rolled-ribbed sheet. It may be treated much like ordinary sheet stock, but sufficient bend radius must be allowed for bends across the stiffener sections. Samples of formed parts made on conventional tools are illustrated in Fig. 10.

Rolled-ribbed stock may be cut and trimmed with conventional power shears if the stiffeners are protected from the clamping rams by a piece of heavy sheet used as a buffer plate. The portion to be trimmed away is placed under the blade since this becomes irregularly bent. Gentle curvatures may be handled on ordinary rolls; sharp bends may be made with the power brake using the conventional punch and dies. Excellent joggles have been formed on the power brake using shims and plates.

In some cases it is desirable to remove the stiffener elements over a portion of the rolled-ribbed sheet to

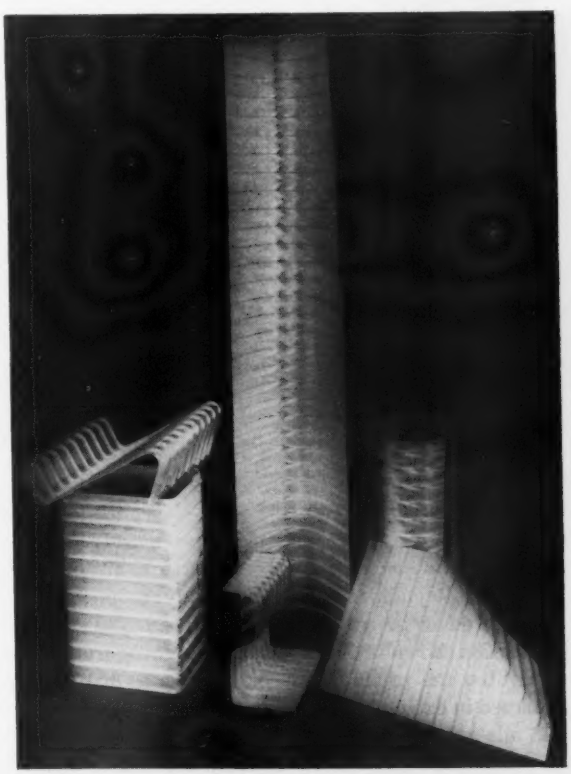

FIG. 10. Sample forming in rolled-ribbed sheet: conventional sheet-metal tools were used.

permit sharp bends (such as for a tab trailing edge) or to allow attachment to a plain flange. This has been accomplished satisfactorily as a routing operation, using a flat-bottom cutter turning at high speed and clamping plates adjacent to the area to be worked.

Extruded Integrally Stiffened Sheet

Previous Work

Several shapes of practicable dimensions for integrally stiffened aircraft surfaces have already been extruded although as far as is known none have as yet been used for this purpose.

The maximum size of the extruded section is determined primarily by the dimensions of the extrusion press (die diameter), and length is limited by billet size. The available extrusion pressure limits the complexity of the section shape and determines minimum thicknesses and fillets for successful extrusion of a particular shape. The limitations are interrelated and differ with various materials; the larger size extrusions in the harder alloys must have correspondingly thicker webs.

To take maximum advantage of press capacities, Dow Chemical Company several years ago produced an "octopus"-type section similar to that shown in Fig. 11b. This circular section was then split, heat-treated, and flattened to form a 17-in. wide sheet with integral bulb stiffeners. Dow Chemical Company has also produced a 9-in. wide T-stiffened section, similar to Fig. 11c, by extruding in the flat. Both of these sections were made in magnesium alloy. Difficulty was experienced in obtaining satisfactory flatness in the surface after heat treatment.

Current Availability

Section Shape.—A logical configuration is provided by regularly spaced T-stiffeners, the spacing being determined by skin-buckling requirements and the stiffener flanges providing high crippling strength and high section moment of inertia. An unsymmetrical flange may be advantageous for attachment but is not quite as efficient (tends to roll) in bending or column action, particularly if the web and skin are thin.

Flat Extrusion.—In Fig. 11c, a section is shown which might be used in the upper surface structure of the wing of a large transport airplane. This section is naturally limited in width by the extrusion press die diameter.

Circular Section Extrusion.—Under a contract with U.S.A.F., Reynolds Metals Company is proceeding with the development of tools and processes to extrude the section shown in Fig. 11b and split, heat-treat, and straighten the product. Successful results have been obtained in extruding the hollow shape in 61S, 24S, and 75S alloys, and it is believed that parts of widths and thicknesses comparable to standard sheet sizes can be produced on present equipment. Considerable variation in section details will also be permissible. This

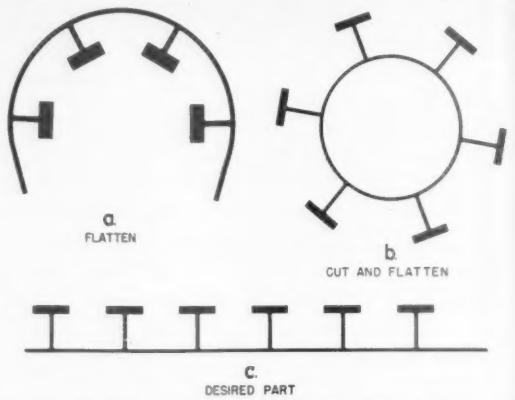

Fig. 11. Various methods of producing desired shape using extrusion.

method of extrusion makes possible as a future development the production of a tapered-skin integrally extruded section.

Semicircular Sections.—To obtain sections of width larger than available die diameters and yet avoid some of the extrusion and straightening problems encountered in Fig. 11b, the shapes shown in Fig. 11a have been proposed by Alcoa. The thickness limitations in this case are approximately the same as for flat extrusions.

Application

For surface structure such as wing panels, fuselage, and empennage surfaces, where loads are high and there are few irregularities in contour or structural continuity, integrally stiffened extrusion shows exceptional possibilities. Extruded sections have high physical properties, and, because of the excellent detail configuration, they will generally carry unusually high compressive stresses even with widely spaced supports. Thus, both weight advantage and simplification of internal structure can be obtained.

The T-stiffener configuration makes for simplicity and efficiency where attachments, splices, and joints are required. Because extrusion will be obtainable in long lengths, reduction in the number of chordwise splices is generally possible. For some applications it may be worth while to machine the extruded section to obtain taper in skin thickness and section depth and to make integral reinforcements and attachment pads.

Press-Forging

Production of thin-skinned surface panels with deep-section integral stiffening by press forging has become more feasible with recent advancements in technique and press capacity. During the war, Germany had a press of 30,000 tons capacity; some large slab-shaped parts were made in quantity on this press, but none approached stiffened-skin surface structure in minimum thickness or complexity of detail. The largest press in this country has a capacity of 18,000 tons and is operated by Wyman-Gordon Company in Worcester, Mass

Current Development

Under a U.S.A.F. contract, Lockheed is now working with the Wyman-Gordon Company to determine if integrally stiffened structure, such as that shown in Figs. 1 and 2, can be profitably produced by press-forging. Considerable progress has been made in development of dies and in forging technique. Results of an early phase of the program are illustrated in Fig. 12. This panel is 25 in. square with 1-in. stiffeners spaced at $1^1/_2$-in. intervals. A few years ago, the forging of such specimens was considered impossible; results to date definitely prove the feasibility and practicability of making large surface panels by this method although more development work remains to be done.

Forging to Contour

The question of forging to finished contour or forging flat is still to be answered. Forging dies that will produce a part to finished contour may be more expensive than dies producing only a flat blank. However, if the dimension can be held within required limits it would eliminate forming. If dimension cannot be held or surface smoothness is insufficient, other additional machining or straightening operations are required. If the forging could be made to required dimension and surface smoothness was satisfactory, the problem of machining for desired accuracy at joints and other attachment areas would be more difficult in a formed part than in a flat.

Applications

Press-forging would practically eliminate fabrication and assembly operations in the aircraft plant. In certain cases, considerable weight advantage may also be found. The wing panel illustrated in Fig. 1 weighs 76 lbs. in conventional construction; as an aluminum-alloy forging, its weight is only 56 lbs.; if forged from magnesium alloy, 46 lbs.

Fig. 13 illustrates the design of a wing-surface panel for press-forging. This panel must carry both end compression and normal air pressure; in this case, this is best accomplished with two sets of stiffening elements. In the forged design, these are obtained by the waffle-grid arrangement. The weight is the same as that of the conventional design, but the part is made of one piece instead of 49.

Another example of a part suitable to the press-forging method is the one-piece bulkhead rib shown in Fig. 2.

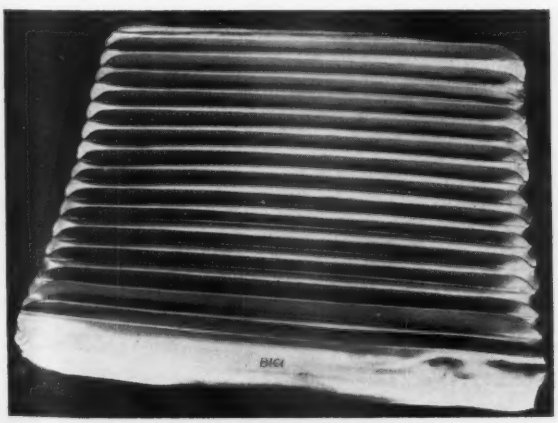

FIG. 12. Integrally stiffened test section produced by press-forging.

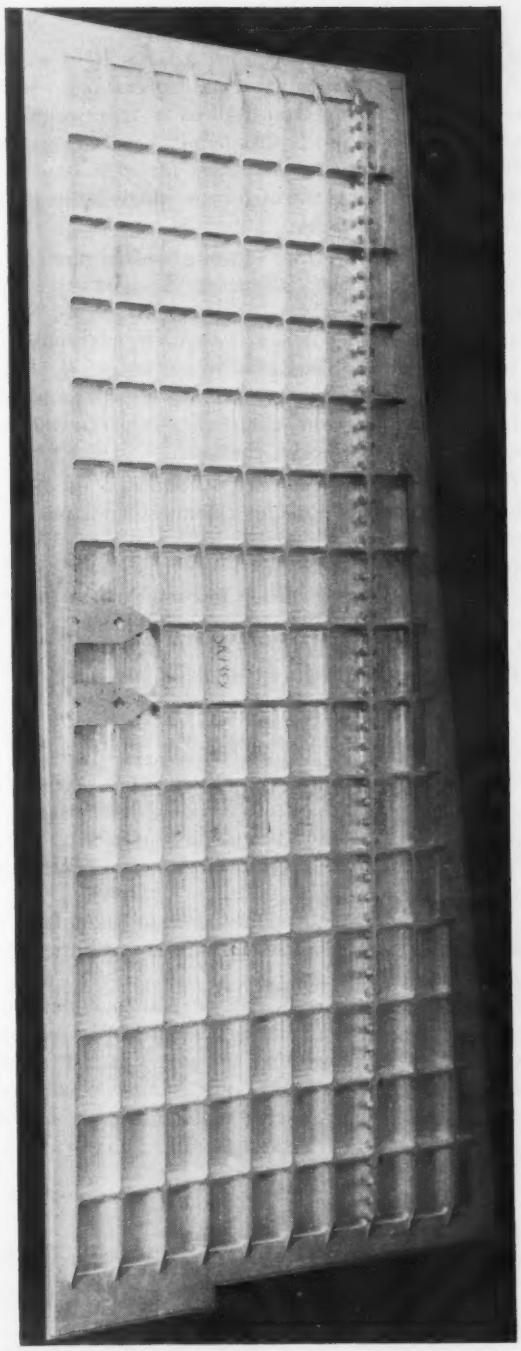

FIG. 13. Press-forging design simulated by machining: proposed one-piece surface panel for P-80 wing (splice was necessitated by limited material size).

Casting

Casting as a production method has inherent advantages because it eliminates many operations in preparation of the material as well as in fabrication and assembly of the part. It also permits the complexity of detail which is usually necessary for high structural efficiency. That it is not used more widely is due to the following disadvantages:

(*1*) *Material Properties.*—Strength of cast material is generally only about half as much as that for the wrought alloy.

(*2*) *Technological Limitations.*—As the size of castings is increased, the problems of warpage, shrinkage, homogeneity and porosity become more severe. If minimum thicknesses are too large, cast surface structure will not be able to compete on a weight basis.

Studies were made of the possibilities of both aluminum- and magnesium-alloy castings for wing-surface and tail-surface panels for the F-80 airplane. Weight penalties were indicated in every case, but casting should be given consideration in connection with new design problems not only because of the possible effect of special requirements or conditions but also because of recent advancements in the technique of casting.

Summary of Conclusions

The major cost item in present-day aircraft construction is assembly and assembly tooling. Through integral stiffening design—combining skin and skin stiffeners in one unit—assembly costs may be greatly reduced.

Additional advantages are found in the inherent high rigidity and surface smoothness of integrally stiffened construction.

Many different methods may be used to achieve integrally stiffened construction. Some show disadvantages in parts fabrication and material cost which offset the savings in assembly. For example, machining from thick plate affords a good method of experimental or prototype construction, and, as a production method, it is itself worthy of serious consideration. However, fabrication costs are high, and the large material wastage incurred is basically unsound.

Material costs are much lower for parts produced by extrusion, but, because this method results in a constant section, machining will generally be required to gain the additional advantages of thickness taper, integral doublers, and integral pads. Meanwhile, the present high cost of machining (fabrication cost) can be reduced by the use of suitable high-speed machining equipment and, if warranted by quantity production, the development and use of automatic controls.

For lightly loaded portions of the aircraft structure, a light-gage rolled-ribbed sheet offers great possibilities for simplification and reduction in cost and the additional advantage of external smoothness.

Press-forging will be especially advantageous for large quantity production; in such cases, it offers great flexibility of detail design and maximum simplification and reduction in number of parts. It will probably have size-vs.-minimum-thickness limitations determined by press capacities.

It appears that by the combined use of several of these methods, the overall cost of aircraft construction can be materially reduced. Much more development work must be done before the advantages can be fully realized.

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Designing for Comfort in Aircraft Seats*

STANLEY LIPPERT†

Douglas Aircraft Company, Inc.

Introduction

THE COMFORT ASPECTS of seat design are discussed, and design procedures based on literature surveys and company tests are established. The report includes:

(1) Dimensional data on several population groups.

(2) Correct position in space for a passenger-type chair.

(3) Desirable dynamic properties of seats in gusts and in steady-state vibrations.

(4) A discussion of shock mounts.

(5) A brief discussion on ventilating properties of cushions.

Dimensional Data

The basic dimensional data from American and British sources are compared in a single table, and the usefulness of a probability graph is suggested. A graph of dimensions necessary in seat design is shown in Fig. 1, where selected dimensions are plotted against stature. Fig. 1 is used in connection with a graph showing the distribution of stature in the population of interest.

Position in Space

If a seat is to be designed for the American traveling public, a convenient presentation of essential information can be made. Fig. 2 combines positional and dimensional information of several studies and defines the position in which optimum comfort of 90 per cent of the traveling public can be achieved in a fixed seat. The back is carried high enough to serve as a head rest.

Many compromises between comfort and other requirements must be made in seat design. A practical order of importance of the dimensions shown in Fig. 2 is as follows:

(1) Height of seat above floor, AB (measured to the projected intersection).

(2) Length of seat from front to back ($BC + CD$).

(3) Width of seat.

(4) Included angle between bottom and back ($\angle CDE$).

(5) Break in seat back ($\angle DEF$).

(6) Length of seat back ($DEFG$).

(7) Foot rest.

(8) Clearance between shin and forward seat structure.

(9) Inclination of seat.

(10) Height of arm rest above seat.

As an example of the application of the above sequence, $\angle ABC$ can be compromised with little effect on comfort, whereas $\angle CDE$ is critical. Fig. 2 is a good starting point for seat design and for the evaluation of a seat design in terms of comfort. If an adjustment is to be provided for the seat back, the position shown should be one of the stops. A preferred adjustment for a limited range of motion is one where $\angle ABC$ alone changes. If this is not possible, a change in $\angle ABC$, together with a change in $\angle CDE$, is desirable. An adjustment in $\angle CDE$ alone is the least desirable, but most common type of, adjustment.

Fig. 2 defines a comfortable position in space. In designing a seat, the spring rates of the cushion and cushion supports and the applied pressures at various

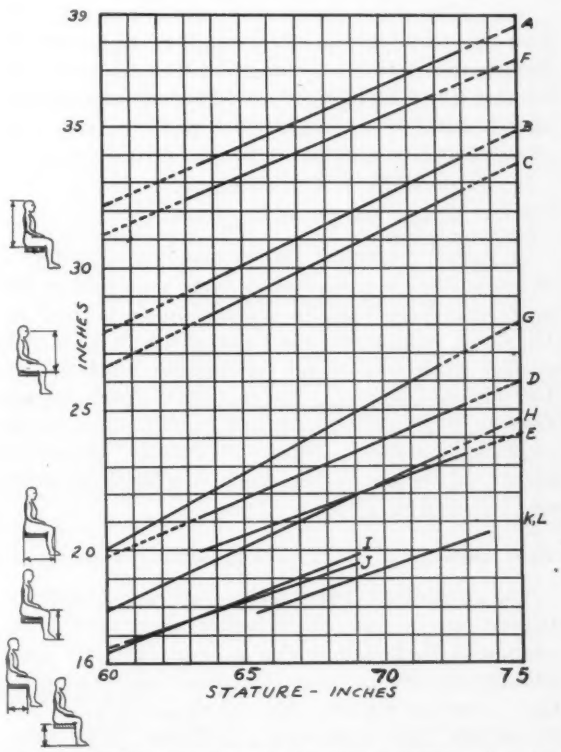

FIG. 1. Body dimensions as a function of stature. A = sitting height, Cadets and Gunners*; B = eye height, erect posture, C. and G.*; C = eye height, relaxed posture, C. and G.*; D = buttock to knee, C. and G.*; E = patella height, C. and G.*; F = sitting height, women pilots*; G = buttock to knee, women pilots*; H = patella height, women pilots*; I = seat length, Hooton—women; J = seat height, Hooton—women, some shoes on, some off; K = seat length, Hooton—men; L = seat height, Hooton—men, shoes on. * From AAF TR5501, *Nude Dimensions*.

* Condensation of a Douglas Aircraft Company report.

† Interiors Design Group.

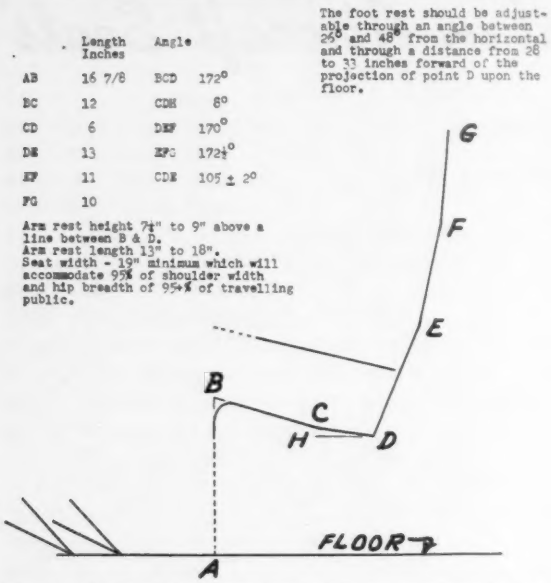
Length Inches
Angle
AB 16 7/8 BCD 172°
BC 12 CDH 8°
CD 6 DEF 170°
DE 13 EFG 172½°
EF 11 CDE 105 ± 2°
FG 10
The foot rest should be adjustable through an angle between 26° and 48° from the horizontal and through a distance from 28 to 33 inches forward of the projection of point D upon the floor.
Arm rest height 7¾" to 9" above a line between B & D.
Arm rest length 13" to 18".
Seat width - 19" minimum which will accommodate 95% of shoulder width and hip breadth of 95% of travelling public.
G
F
E
B
C
H
D
FLOOR
A

FIG. 2. Comfortable supporting surface for passenger in fixed seat.

points on the cushion must be so regulated that the passenger occupies this position.

Fig. 2 shows a comfortable, but not a soldierly, posture; those persons who must have support in the lumbar region must resort to the use of a pillow. The forward tilt of *EF* in Fig. 2 not only gives more comfort than a straight-backed chair but gives an extra 2 in. of clearance for passengers in the seat behind.

CUSHIONS AND PADS

If a firm supporting surface conforming to Fig. 2 is constructed, a $^1/_2$-in. slab of latex foam rubber, say of a medium grade for the bottom and a soft grade for the back, would reasonably constitute a minimum cushion where no dynamic problems are involved. In the airplane, however, two important dynamic considerations affect seat-comfort design. The entire airplane at times is displaced vertically upward or downward in gusts, and the floor and sidewalls to which seat attachments are made vibrate.

Gust Loads

The gusts of greatest frequency are of moderate intensity, but 1*g* gusts are statistical occurrences. Prevention of bottoming during a 1*g* up-gust is a good working criterion for an aircraft cushion and its support. Once a cushion has been thus deflected, it will continue to oscillate with decreasing amplitudes. This effectively prolongs an uncomfortable disturbance unless an appropriate amount of damping is built into the oscillating system. The degree of damping most conducive to riding comfort lies between 0.15 and 0.20 critical damping. This degree of damping does not seriously affect the steady-state vibration isolation qualities of a cushion.

Vibration Isolation

If the amplitude and frequency of the vertical floor vibrations in an airplane are plotted on a graph of vibration comfort levels, the degree of attenuation required to give a specified vibration comfort level is determined. By selecting an appropriate natural frequency of the loaded cushion, the desired attenuation can be achieved. Information on spring rates is not generally furnished by the manufacturers of cushion materials and must be secured by tests.

Dynamic tests on several seats have indicated that the theory does not precisely indicate seat behavior but is a valuable aid to correct design.

The selection of a back cushion follows the same procedure as the selection of a bottom cushion, except that a softer cushion is required, because of the lighter loads, to attain comparable vibration attenuation.

Many cushions are too plush for comfort. Such cushions waste weight, bottom during heavy gusts, jackknife the occupant into an uncomfortable position, and may even initiate or aggravate tenderness in the coccyx. Where the cushion rests upon a flexible base, the spring rate of the cushion and the base must be considered together.

CONVENTIONAL SHOCK MOUNTS

The insertion of individual shock mounts between the legs of an aircraft seat and the floor is frequently proposed by designers as a means of reducing the vibration felt by the passenger when an airplane is found to have excessive vibration. In general, this is not good practice. The passenger on the cushion and the seat on the shock mount constitute a system having two degrees of freedom. For the nominal deflections permissible in shock mounts, the major effect is the introduction of resonant frequencies in the system where previously

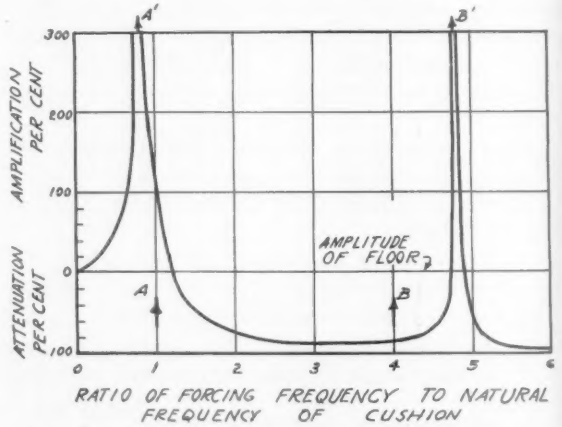

FIG. 3. Effect of shock mounts on a cushioned seat. A = natural frequency of cushion only with passenger load; A' = frequency of cushion with passenger load when shock mount is in the system; B = natural frequency of shock mount only with passenger load; B' = frequency of shock mount when in same system as cushion.

This graph is based on a passenger load on the seat seven times as great as the weight of the seat and on a shock mount whose natural frequency is four times that of the seat bottom cushion and cushion support.

the cushion was already attenuating nicely, as shown in Fig. 3; a variety of pitching and yawing motions, which the rigidly attached seat would not have had, is also made possible. Dynamic tests on conventionally shock-mounted seats made several years ago by the Douglas Aircraft Company, Inc., indicated erratic response patterns not noted in rigidly attached seats. The argument against shock mounts holds over the entire range of seat and passenger weights that can reasonably be expected to be encountered. Fig. 3 illustrates the results based on theoretical considerations.

One of the fallacies of shock-mounting a cushioned seat is that, even if excellent attenuation is attained, the floor itself will still be vibrating with sufficient intensity to annoy the passenger. It is better, therefore, to assure the passenger a moderately comfortable vibration experience over the entire body than to give him excellent isolation in some parts and poor isolation in other parts of the body.

Cushion Ventilation

Most cushion materials are poor heat conductors. In warm weather especially, the problem of ventilating the cushion becomes important. All else being equal in two cushions, the one that allows the air to circulate most freely should be selected. In the absence of a better description, it seems that flow resistance, a quantity used in the clothing and acoustical fields, is useful. The flow resistances of some common aircraft materials are tabulated.

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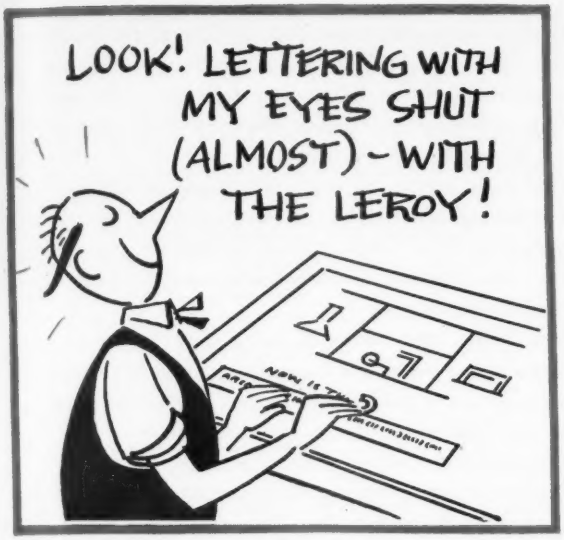

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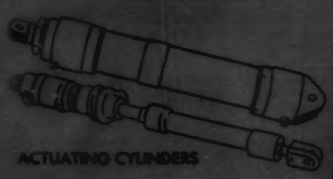

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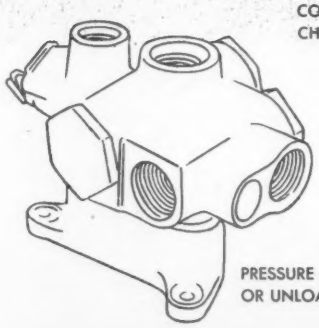

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Aerodynamics (2)

Research at Work. I. *Interavia*, Vol. 4, No. 9, September, 1949, pp. 561–564, illus., figs.

Review of current trends and objectives in supersonic and subsonic aerodynamic research, based on recent publications of American, British and French research organizations. Reference is made to the utilization of electronic calculating machines and devices for simulating flight conditions for research purposes.

AERODYNAMIC LOADS

A Comparison of Wing Loads Measured in Flight on a Fighter-Type Airplane by Strain-Gage and Pressure-Distribution Methods. William S. Aiken, Jr., and Donald A. Howard. *U.S., N.A.C.A., Technical Note No. 1967*, November, 1949. 27 pp., diagrs., figs. 2 references.

BOUNDARY LAYER

The Stability of a Plane Laminar Flow Under Positive and Negative Pressure Gradients. J. Pretsch. (*Göttingen, Aerodynamische Versuchsanstalt, Report*, November 7, 1945.) *Australia, Council for Scientific and Industrial Research, Division of Aeronautics, Translation No. 10*, April, 1946. 59 pp., figs. 12 references.

The effect of two-dimensional disturbances on the stability of plane laminar flow shows a negligible dependence of the velocity and the disturbance amplitude on the arc length along the body. A stability limit expressed as a Reynolds Number below which all disturbances are damped can be found for each laminar velocity distribution independently of its previous history. Calculations were made based on the exact distributions obtained by Hartree from the boundary-layer equations. In the region of falling pressure the solution was obtained by replacing the second order disturbance differential equation by a binomial function of the distance from the wall. In the regions of rising pressure a sine-like function was used. The stability limit falls rapidly from the stagnation point to the laminar separation point. The distribution can be uniquely determined by Pohlhausen's approximate method for the solution of the laminar boundary layer so that for each plane boundary layer formed under a definite pressure distribution and Reynolds Number a point can be given in front of which the flow is stable. Comparison of calculations made with seven symmetrical Kármán-Trefftz profiles at zero lift, the N.A.C.A. profile 2,409 for different lift coefficients and a sine-like corrugated wall, shows that the stability limit falls somewhat wide of the actual transition point. However, quantitatively both points behave similarly when the Reynolds Number and the pressure distribution are varied.

Heat Transfer in Laminar Compressible Boundary Layer on a Porous Flat Plate with Fluid Injection. Shao Wen Yuan. *Journal of the Aeronautical Sciences*, Vol. 16, No. 12, December, 1949, pp. 741–748, figs. 4 references.

A Theoretical Discussion of High-Lift Aerofoils with Leading-Edge Porous Suction. B. Thwaites. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2242*, July, 1946. 9 pp., figs. 5 references. British Information Services, New York. $0.50.

Investigations Relating to the Extension of Laminar Flow by Means of Boundary-Layer Suction Through Slots. Laurence K. Loftin, Jr., and Dale L. Burrows. *U.S., N.A.C.A., Technical Note No. 1961*, October, 1949. 58 pp., figs. 10 references.

Present Status of Research on Boundary-Layer Control. A. E. von Doenhoff and L. K. Loftin, Jr. *Journal of the Aeronautical Sciences*, Vol. 16, No. 12, December, 1949, pp. 729–740, 760, illus., figs. 43 references.

Readers' Forum: An Experimental Verification of Local Isotropy. Stanley Corrsin. *Journal of the Aeronautical Sciences*, Vol. 16, No. 12, December, 1949, pp. 757, 758, fig. 5 references.

CONTROL SURFACES

Two-Dimensional Hinge Moment Calculations. P. Mandl. *Canada, National Research Council, Report No. MA-214*, October, 1948. 41 pp., diagrs., figs. 11 references.

Control hinge moments at zero deflection have been determined by calculating the pressure distribution over the surface of three types of ailerons: round-nose, flat sided with sealed gap; round-nose, flat sided with unsealed gap; and a flat-sided Frise

aileron. Attempts have been made to take account of the effects of the boundary layer in the hinge moment characteristics by suitably modifying the theory of potential flow.

FLUID MECHANICS & AERODYNAMIC THEORY

The Formation and Growth of Shock Waves in the One-Dimensional Motion of a Gas. A. F. Pillow and H. C. Levey. *Australia, Council for Scientific and Industrial Research, Division of Aeronautics, Report No. A.47,* December, 1947. 60 pp., figs. 6 references.

By neglecting reflections and entropy variations behind the shock, a first approximation is found for the motion of a homogeneous gas in an infinite tube which is caused by a constantly accelerated piston that closes the tube at one end. A second approximation is then found for the entropy in the neighborhood of the initial portion of the shock curve. The problem is thus reduced to the solution of a second order, linear, partial, differential equation. The introduction of a Riemann function and the satisfaction of the boundary conditions at the shock lead to an integral equation whose solution enables the position of the shock to be determined as a function of time. The solution is a power series and is valid if the shock wave does not become too strong. When allowance is made, in this way, for the reflections and entropy variations behind the wave, the velocity of the shock is slightly higher than in the simpler case when these are neglected. If the piston is given a constant terminal velocity, a reflected wave from the shock is reflected again at the piston and eventually overtakes the shock and reduces its velocity to a final steady value that is in agreement with the value determined by elementary considerations.

Shock Waves in Arbitrary Fluids. Hermann Weyl. *Communications on Pure and Applied Mathematics,* Vol. 2, Nos. 2, 3, June-September, 1949, pp. 103–122, figs. 3 references.

The investigation attempts to clarify the general hydrodynamical and thermodynamical foundations of the shock phenomenon. The first part answers the question about the conditions for the equation of state under which shocks may be produced. Those conditions, dealing with the adiabatic increase of pressure, compression rate, and volume, are partly of differential nature and partly of global nature. The second part investigates the physical structure of the shock layer whose "infinitesimal" width is of a small magnitude. Initial state and final state are singular points for the differential equations of the shock layer, and they are of such nature as to require a unique solution of the problem.

The Efficiency of Compression in a Single Adiabatic Shock; Results of Some Calculations on the Case When No Heat Is Released. A. W. Morley. *Aircraft Engineering,* Vol. 21, No. 248, October, 1949, pp. 320, 321, 324, figs.

Drag and Pressure Measurements with Plaster Spheres in Windtunnel 3 and 4 of the National Aeronautical Research Institute. S. I. Wiselius. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. A.950,* 1947. 8 pp., diagrs., figs. 3 references. (In English.)

Drag and pressure measurements were made with two lacquered and polished plaster spheres in the closed working section of tunnel number three and in the open working section of tunnel number four, to determine the airflow turbulence and the influence of the sphere diameter of the supporting spindle diameter, and of the tension in the suspension wires on the critical Reynolds Number. The spheres and the method of suspension and measurement are described. The airflow in the closed jet is less turbulent than that in the open jet; the spindle diameter has some effect on the drag curves, but the critical Reynolds Number is almost unaltered, and a decrease in the tightening loads has about the same effect as an increase in the spindle diameter.

Rotationally Symmetric Potential Flow. Manfred Schäfer and W. Tollmien. (*Dresden, Technische Hochschule, Archiv Nr. 44/4,* November 18, 1940.) *U.S., N.A.C.A., Technical Memorandum No. 1244,* November, 1949. 31 pp., figs. 5 references.

Problems in the Theory of Viscous Compressible Fluids. Paco A. Lagerstrom, Julian D. Cole, and Leon Trilling. *California Institute of Technology, Pasadena, Calif., Guggenheim Aeronautical Laboratory, Report on Research Conducted under Office of Naval Research Contract No. N6onr, Task Order No. VIII,* March, 1949. 200 pp., figs. 60 references.

The propagation of a viscous wave, in certain cases, may be regarded as a superposition of two effects. The first is a propagation of the nonviscous type which is determined by the characteristics of the equations of nonviscous flow, or subcharacteristics. The pertinent characteristics are the Mach lines, or hyperbolic characteristics, for the longitudinal waves, and the streamlines for the transversal waves. The second effect, which propagates a viscous wave, is viscous diffusion from the subcharacteristics. That diffusion is due to the parabolic nature of the equations and is very similar to the propagation of heat. This description is always valid for transversal waves, with the rate of diffusion depending upon the viscosity. In the case of longitudinal waves, however, the description is valid only asymptotically for large values of certain local Reynolds Numbers. For high local Reynolds Numbers the propagation of the longitudinal wave is dominated by the compressibility effect, since the hyperbolic characteristics are just those lines along which disturbances due to compressibility propagate in a nonviscous fluid. For low local Reynolds Numbers the longitudinal wave shows only diffusion of parabolic type. The viscous effect is dominant and the effects of compressibility are secondary. For longitudinal waves the solutions are given in the form of contour integrals, and further analysis may indicate the nature of the flow in the intermediate range of Reynolds Numbers. For transversal waves, compressibility has no effect. In that case the solutions are obtained in closed form in terms of functions related to the solutions of the heat equation. The assumptions are that heat conduction is neglected, disturbances are small, and the equations are linearized.

Two-Dimensional Motion of a Gas at Large Supersonic Velocities. S. V. Falkovich. [*Prikladnaia Matematika i Mekhanika,* (*U.S.S.R.*), Vol. 11, 1947.] *U.S., N.A.C.A., Technical Memorandum No. 1239,* October, 1949. 10 pp., fig. 8 references.

Two-Dimensional Potential Flows. Manfred Schäfer and W. Tollmien. (*Dresden, Technische Hochschule, Archiv Nr. 44/3, Kapitel 3,* March 22, 1941.) *U.S., N.A.C.A., Technical Memorandum No. 1243,* November, 1949. 24 pp., figs. 9 references.

On the Production of Turbulence in Flow Along a Plate. H. Schlichting. (*Gesellschaft der Wissenschaften zu Göttingen, Mathematische-Physikalische Klasse, Nachrichten,* 1933, pp. 181–208.) *Australia, Council for Scientific and Industrial Research, Division of Aeronautics, Translation No. 6,* July, 1944. 34 pp., figs. 24 references.

The Propagation of Waves in Shallow Water. Sherman Cabot Lowell. *Communications on Pure and Applied Mathematics,* Vol. 2, Nos. 2, 3, June-September, 1949, pp. 275–291, figs. 13 references.

Mathematical Solution of the Problem of Roll-Waves in Inclined Open Channels. I. II. Robert F. Dressler. *Communications on Pure and Applied Mathematics,* Vol. 2, Nos. 2, 3, June-September, 1949, pp. 149–194, figs. 21 references.

A New Treatment of the Ship Wave Problem. A. S. Peters. *Communications on Pure and Applied Mathematics,* Vol. 2, Nos. 2, 3, June-September, 1949, pp. 123–148, figs. 8 references.

Speed of Rise of Air Bubbles in Liquids. T. Bryn. (*Forschung, Vol. 4, No. 1, January-February, 1933.*) *U.S., Navy, The David Taylor Model Basin, Translation No. 132,* June, 1949. 7 pp., figs. 5 references.

An Investigation of the Backwater Profile for Steady Flow in Prismatic Channels. Wallace M. Lansford and William D. Mitchell. *Illinois, University, Bulletin,* Vol. 46, No. 51, March, 1949. (*Engineering Experiment Station Bulletin, Series No. 381.*) 96 pp., illus., diagrs., figs.

The Effect of Natural Winds on Larger Circular Cylinders. (*Verein Deutscher Ingenieure, Zeitschrift,* Vol. 81, No. 13–14, April 4, 1942, p. 220.) *Australia, Council for Scientific and Industrial Research, Division of Aeronautics, Translation No. 3,* August, 1943. 7 pp., figs. 2 references.

Application of the Analogy Between Water Flow with a Free Surface and Two-Dimensional Compressible Gas Flow. W. James Orlin, Normal J. Lindner, and Jack G. Bitterly. *U.S., N.A.C.A., Report No. 875,* 1947. 18 pp., illus., diagrs., figs. 9 references. U.S. Govt. Printing Office, Washington. $0.15.

Elastic Deformation of Thin Ellipsoidal Shells Under Hydrodynamic Pressures. Phillip Eisenberg. *U.S., Navy, The David Taylor Model Basin, Report No. 606,* July, 1949. 22 pp., figs. 3 references.

Nomogram for Calculating Quantity of Flow. *Product Engineering,* Vol. 20, No. 9, September, 1949, p. 165.

INTERNAL FLOW

The Performance of Axial Flow Compressors as Affected by Single Stage Characteristics. Seymour M. Bogdonoff. *Princeton*

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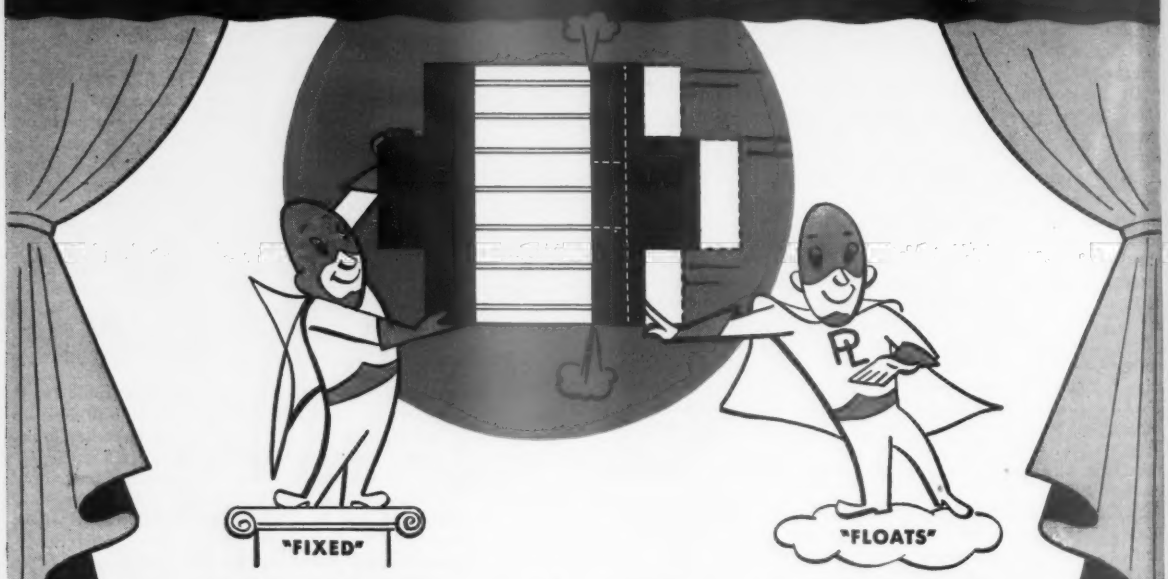

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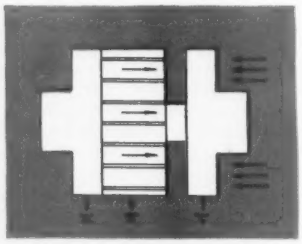

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Air Transportation (41)

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In order to extend air transport to those parts of the world most in need of it, aircraft must be designed with less weight, greater pay load, and no fewer than two engines. If power plant weight can be reduced to 1 lb. per hp., or less, power loading can be reduced by at least one third and speed thereby increased without sacrifice of pay load. Cruising speeds have increased 150 per cent in the past 20 years because of aerodynamic improvement, lower power loading, and higher altitude operation. The turboprop engine offers advantages in power-weight ratio and power loading. The two greatest accomplishments of the past 30 years are lower cost and longer range. The greatest future needs are improved economy and reliability. Higher aerodynamic efficiency giving 15 per cent greater speed would reduce operating cost by 10 per cent, on flights of 400 to 500 miles. If design can produce no further economies, operating practice must be revised to achieve this end. Reliability must be improved. An average of 95 per cent of on-time arrivals is a reasonable expectation, and flight cancellations or diversions due to ground weather should be reduced by 90 per cent. Take-off and landing distances must be shortened. No runway should be longer than 7,000 ft. By the use of supplementary thrust devices such as rocket-assisted take-off and reversible propellers or rocket brakes to shorten the landing run, 2,500 ft. should be a reasonable future goal for the length of runways.

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Survey of the evolution of aircraft structural design; developments in aerodynamics, compressibility and supersonic flight; modern power plants, gas turbines, ram jets, and rockets; and rotating-wing aircraft. Future wing design will rely on removal or reinforcement of the boundary layer and will be more complex than present forms. The all-wing or tailless aircraft is expected to predominate for large, long-range high speed passenger and mail service. Three methods for delaying the increase of drag coefficient as Mach Number rises are to reduce wing curvature, sweep the wings back, and reduce the aspect ratio. Future gas turbines with axial-flow compressors will have higher efficiencies and double the present compression ratios. Working temperatures of turbine blades will increase from about 700 °C. as at present to 900 °C. or more. Ram-jet engines will give sharply rising overall propulsive efficiency as aircraft velocity rises into the supersonic ranges. Liquid-fuel rocket power plants offer the triple advantages of comparative simplicity and cheapness, thrust ratios of 10,000 to 30,000 lbs. per sq. ft. of combustion-chamber cross section, and constant thrust at high altitudes. Available metals within the foreseeable future will limit rocket combustion temperatures to 2,000 ° to 3,000 °C., so the main hope of improving the specific impulse rate will depend upon lowering the molecular weight of the jet gases. Rotating-wing aircraft will find increasing utilization in air-taxi transportation between crowded cities and outlying airports, in private flying, and in postal transport, crop dusting, and pest control.

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Calculation of the loads resulting from the application of brakes, caused by the transference of load to the nose wheel and by the local transference of load between the wheels of the bogie itself. Undue wear on the tires can be avoided by careful positioning of the bogie-pivot point to minimize the load transference, or by the use of compensating linkage.

PRELIMINARY DESIGN

Hoe Staat het met het Luchtvrachtvervoer (What is the Status of Air-Freight Transport)? *Vliegwereld*, Vol. 15, No. 34, August 25, 1949, pp. 558, 559, 564, illus., figs. Résumé of Studies by Fokker Aircraft.

Aerodynamic Cleanness. E. J. Richards. *Flight*, Vol. 56, No. 2135, November 24, 1949, p. 671.

Military Air Transport Service Specification Requirements for Cargo Aircraft. Raymond R. Hajek. *Aeronautical Engineering Review*, Vol. 8, No. 12, December, 1949, pp. 27–31, illus.

WINDSHIELDS

Impact Testing of Aircraft Windshields by Means of a Dropping Projectile. B. M. Axilrod and M. S. McKinney. *U. S., Civil Aeronautics Administration, Technical Development Report No. 95*, August, 1949. 23 pp., illus., diagrs., figs. 2 references.

Warm Outlook; New Developments in Thermal De-Misting of Windscreens. *Flight*, Vol. 56, No. 2134, November 17, 1949, p. 645.

WING GROUP

Smooth Wing; High Speed Requirement. Robert McLarren. *Aviation Week*, Vol. 51, No. 23, December 5, 1949, pp. 21, 22, 24, fig. 9 references.

Ilmailutekniikan Perusteita (Fundamentals of Aircraft Engineering). III. Ilmailu (Helsinki), No. 3–5, 1949, pp. 10, 11, figs. The operations of ailerons, flaps, and control booster systems explained.

Airports & Airways (39)

Trends in Aviation Facilities Planning. Robert L. Champion. *Paper presented at 1° Congresso Panamericano de Engenharia at Rio de Janeiro*, Brazil, July 20, 1949. 13 pp.

Airport design must keep in step with advances in aircraft design, in civil engineering and construction techniques, and in the development of operational procedures and equipment for all-weather flying. Runway layout can be simplified and shortened and total airport areas can be reduced when cross-wind multiple-wheel and caterpillar landing gear are perfected. Rocket or jet assisted take-off and braking, reverse-pitch propellers, and parachute brakes will offset the trend toward longer runways, caused by the greater aircraft speeds. Improved loading, servicing, and fueling facilities will reduce ground time and offset the need for larger aprons due to the increasing size and number of aircraft in operation. For runway construction, minimum slab thickness of 20 in. is indicated, and flexible pavements may require foundations 72 in. thick. Prestressed concrete-block construction with transverse cables laid between the blocks and anchored in patented interlocking cones is expected to carry loads 15 times greater than ordinary construction of the same thickness. New and more durable surface materials consist of powdered natural rubber latex mixed with bituminals. Improved all-weather operational techniques involve the use of ILS or GCA, or a combination of those, high-intensity lighting and marking of the runway, and fog-dispersal systems.

Operational Research into Air Traffic Control. G. E. Bell. *Royal Aeronautical Society, Journal*, Vol. 53, No. 466, October, 1949, pp. 965–976, Discussion, pp. 977–996, figs. 3 references.

Experimental and theoretical investigations, including time and motion studies of take-off and landing, studies of air and ground communications, and analyses of the traffic patterns in southeastern England, show the necessity for finding techniques involving the minimum waste of time or the most economical use of time, and lead to the idea of flow control. Long delays are caused by "bunching" of traffic in short-time intervals. The solution of the problems of delays and congestion lies in reducing the holding time to the lowest possible value, resulting in a proportionate increase in airport capacity. At a utilization factor of about 80 per cent and with unchanged traffic volume, a 10 per cent decrease in holding time reduces the average delay by about one-third and the average number of aircraft waiting to land by nearly 50 per cent. The most promising method at present appears to be to extend the use of ground radar control to marshal all aircraft into an orderly sequence. One possible solution employs the technique of the search stage of Ground Controlled Approach over distances much greater than the present range of 15 to 20 miles.

Airwork Comes of Age. *Flight*, Vol. 56, No. 2129, October 13, 1949, pp. 503–505, illus.

Traces the growth and accomplishments of Airwork, Ltd., in sales, service, and pilot training. Present international activities include sales, repair, conversion, and contract charter work for governments, companies, and individuals.

Aeronautical Radio Expanding Activities in Pacific Area. William D. Perreault. *American Aviation*, Vol. 13, No. 13, December 1, 1949, pp. 31, 32, diagr.

Description of the organization, facilities, services, personnel, and procedures of Aeronautical Radio, Inc., which operates com-

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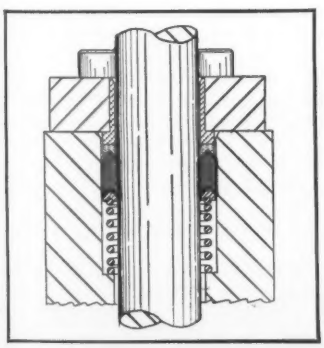

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LOW PRESSURE: 10,108,980 strokes at 0 psi.
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munications systems for air lines in the United States, Puerto Rico, Mexico, Alaska, Hawaii, and Japan.

Charleston (S.C.) Expands Airport Facilities. *American Aviation*, Vol. 13, No. 8, September 15, 1949, pp. 39, 40, illus.

Detroit City Airport. David Shawe. *American Aviation*, Vol. 13, No. 7, September 1, 1949, pp. 41, 42. How local civilian flying has been built up by efficient management and salesmanship.

Burlington (Vt.) Builds Functional Terminal. *American Aviation*, Vol. 13, No. 9, October 1, 1949, pp. 49, 50, illus., diagr.

Rhode Island Adapts Airport Plans to State's Limitations. *American Aviation*, Vol. 13, No. 12, September 15, 1949, pp. 45, 46, illus.

London Airport Interiors. *The Aeroplane*, Vol. 77, No. 2003, October 28, 1949, pp. 592, 593, illus.

Gateway to New England. James F. McManmon. *Aero Digest*, Vol. 59, No. 5, November, 1949, pp. 40, 41, 92–94, illus. Description of the recently expanded facilities of Logan International Airport, Boston, and a review of the development of the terminal.

CAA Reports 224 Airports Abandoned in Six Months. *American Aviation*, Vol. 13, No. 13, December 1, 1949, p. 13.

Airport Design; Notes on Bituminous Construction for Runway Consolidation. H. A. C. Dibbits. *Airports & Air Transportation*, Vol. 4, No. 76, October, 1949, pp. 253–256, illus., figs.

The Preparation of Concrete for Airport Runways. Inge Lyse. *American Society for Testing Materials, Bulletin*, No. 161, October, 1949, pp. 48–50, illus., fig. 1 reference. Description of the concrete material and construction methods used at Sola Airfield, Norway, by which slabs only 8 in. thick gave sufficient load-carrying capacity.

First Progress Report of a Laboratory Investigation of Roadbed Stabilization. Ralph B. Peck. *Illinois, University, Bulletin*, Vol. 46, No. 82, July, 1949. (*Engineering Experiment Station, Reprint Series No. 42.*) 10 pp., illus., figs.

New Airport Revenue Aids Tested at South Bend (Ind.) Field. *American Aviation*, Vol. 13, No. 10, October 15, 1949, pp. 49–51, illus.

Airport Fire Proposals Arouse Industry Protests. *American Aviation*, Vol. 13, No. 10, October 15, 1949, p. 13.

Pulse-Multiplex System for Distance-Measuring Equipment (DME). Charles J. Hirsch. *Institute of Radio Engineers, Proceedings*, Vol. 37, No. 11, November, 1949, pp. 1236–1242, illus., diagrs., figs.

Radio Flight; Proper Procedure is Important in Talking to Tower. Sandy A. F. MacDonald. *Canadian Aviation*, Vol. 22, No. 11, November, 1949, pp. 48, 50, 52, 78, figs.

Helping Make International Flying Safe and Dependable is a Big Job Being Well Done by ICAO. *The Martin Star*, Vol. 8, No. 10, October, 1949, pp. 10, 11, 18, 19, illus.

Atomic Energy (48)

North American Aviation and Atomic Energy. Chauncey Starr. *Skyline*, Vol. 7, No. 3, November, 1949, pp. 4–7, illus., diagr.

The Atomic Energy Research Department of North American Aviation, Inc., is making a preliminary study of a low-power nuclear reactor at the request of the Atomic Energy Commission, in order to develop a safe and useful research tool. The program is directed toward application of heat-transfer technology to the nuclear reactor and the development of suitable structural materials for building such units. The nuclear-power theory is explained briefly and nontechnically.

Aviation Medicine (19)

Comparison of the Physiologic Effects of Positive Acceleration on a Human Centrifuge and in an Airplane. Edward H. Lambert. *Journal of Aviation Medicine*, Vol. 20, No. 5, October, 1949, pp. 308–335, figs. 26 references.

A comparison was made of the responses of 24 subjects to positive acceleration on the Mayo centrifuge and in flight as passengers in a dive bomber. In both cases acceleration was developed at approximately 1.5 *g* per sec. and was maintained for an average of 15 sec. Tolerance to positive acceleration, as determined by the occurrence of visual symptoms, was 0.7 *g* higher in the airplane than on the centrifuge. The difference in tolerance was confirmed by measurements based on loss of the ear pulse, and the higher tolerance in the airplane was attributed to the lower temperatures prevailing in flight and to the more stimulating psychological environment in the airplane, the latter symptom being suggested by the 20 beats per min. faster average heart action. The nature of the symptoms and the basic pattern of cardiovascular responses were the same in flight as on the centrifuge, but the recovery phases of the response to acceleration began one to two sec. earlier in the airplane. Results demonstrate that studies made on the centrifuge can be applied to flight conditions.

Control Action Simulator. Ulrich K. Henschke and Hans A. Mauch. *U.S., Air Force, Air Materiel Command, Engineering Division, Memorandum Report No. MCREXD-696-110D*, July 15, 1949. 14 pp., illus., diagrs., figs. 7 references.

A device for the mechanical simulation of the dynamics of the fundamental types of controls. It contains a position-tracking path and a rate-tracking path in parallel connection, which can be used either separately or in combination. The rate-tracking path is provided with a variable feedback. The differential equation, the frequency-response function, the unit step-input function, and the graph of the latter are given. Examples are computed for the dynamic behavior of a single control action simulator with different adjustments, for two simulators with different adjustments and in cascade or feedback connections.

Effect of the Crouch Position on the Increase in Tolerance to Positive Acceleration Afforded by an Antiblackout Suit. Vincent M. Downey, Fridtjov V. Lorentzen, and Edward H. Lambert. *Journal of Aviation Medicine*, Vol. 20, No. 5, October, 1949, pp. 289–299, illus., figs. 18 references.

Some Physiologic Responses of Airmen on Long-Range Flights in the Arctic. Eugene M. Narsete. *Journal of Aviation Medicine*, Vol. 20, No. 5, October, 1949, pp. 336–342. 16 references.

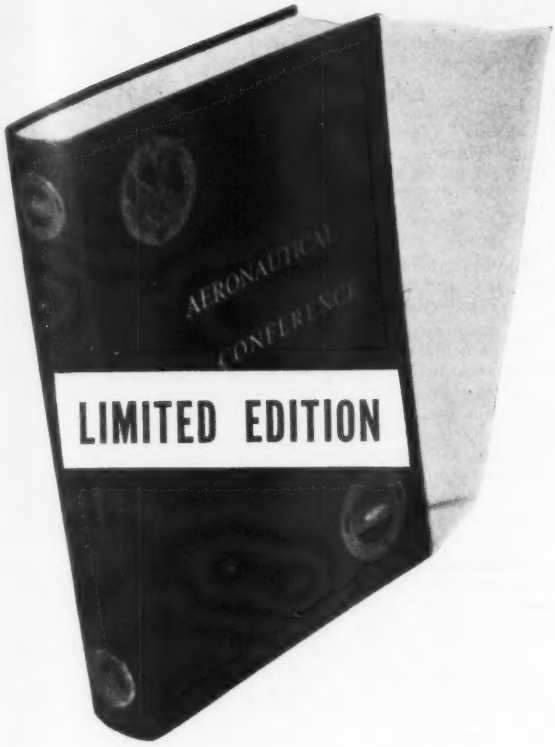
Fifty healthy flight-crew members were subjected to examinations for variations in body temperature during flight missions of 8-hour and 14-hour duration and at periods of 10 to 12 hours after completion of the flights. The group average 8-hour variation ranged from a drop of 0.73°F. for the pilots to a loss of 1.25°F. for the weather observers. The mean average loss in 8 hours was 1.02°F. and at 14 hours it was 1.11°F. The weather observers lost 1.50°F. and the navigators lost 0.77°F. The post-flight period revealed a mean average increase of 0.18°F. over the starting readings. The greatest rise was noted in the weather observers and the least in the radar observers. The reasons for the differences in the group averages are not clear but are probably attributable to environmental conditions, extent of motion, and differences in surrounding temperatures in the various stations in the aircraft. Blood pressures and right radial pulse rates increased as the flight time progressed, and the respiratory rates fluctuated widely but showed an increase on the whole.

The Human Time Factor in Flight; The Latent Period of Optical Perception and its Significance in High-Speed Flying. Hubertus Strughold. *Journal of Aviation Medicine*, Vol. 20, No. 5, October, 1949, pp. 300–307, illus., figs. 28 references.

A Study of Reaction Time to Light and Sound as Related to Increased Positive Radial Acceleration. A. A. Canfield, A. L. Comrey, and R. C. Wilson. *Journal of Aviation Medicine*, Vol. 20, No. 5, October, 1949, pp. 350–355. 6 references.

Note on the Trajectory of the Ejectable Seat. Rosalie Noble, E. S. Mendelson, and J. R. Poppen. *Journal of Aviation Medicine*, Vol. 20, No. 5, October, 1949, pp. 343–349, figs. 2 references.

With seven known conditions, namely, airplane speed, angle of inclination of flight, flight altitude, ejection velocity, angle of seat guide rails from the vertical, and the weight and air resistance of the ejected mass, the trajectory is calculated by means of the equations of motion, curves, and tables of functions. As the guide-rail angle with respect to the vertical becomes smaller, the trajectory has a steeper initial slope, and a forward angle slightly greater than 0° is optimum for clearance. With increasing ejection velocity, all other parameters remaining constant, the vertical component of the velocity becomes greater. Increased air speed raises the horizontal component of the seat mass and thereby flattens the trajectory, making the problem of tail clearance more serious. At higher flight altitudes, where air resistance decreases, the trajectory is steeper, making the clearance problem less critical. Flight tests in which only one variable was altered at a time showed substantial agreement with calculations.



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Dramamine in Pilots. S. William Simon and L. E. Seyler. *Journal of Aviation Medicine*, Vol. 20, No. 5, October, 1949, pp. 371, 379.

Flight-test experiments and chemical analyses showed a tendency toward drowsiness in crew members after taking dramamine as a preventive of airsickness. Possibly 2.5 to 5 mg. of amphetamine might counteract the drowsiness tendency, but the assumption that antimotion-sickness action is not one of sedation has not been proved.

The Life Expectancy of Career Flyers. J. A. Rafferty and S. J. Cutler. *Journal of Aviation Medicine*, Vol. 20, No. 5, October, 1949, pp. 360–364, 375, fig.

Barotitis Media, Hypoxia, Airsickness and Bends in the U.S. Eighth Air Force During World War II. J. A. Rafferty. *Journal of Aviation Medicine*, Vol. 20, No. 5, October, 1949, pp. 356–359.

Insulating Cloth for Cold-Weather Clothing. William O. Perry. *U.S., Central Air Documents Office (Navy-Air Force), Technical Data Digest*, Vol. 14, No. 23, December 1, 1949, pp. 13–19, illus., figs.

Comfortization (23)

Some Aspects of Passenger Comfort in Aircraft. J. W. S. Brancker. *Institute of Transport, Journal*, Vol. 23, No. 6, September, 1949, pp. 172–174, 171.

Space limitations have largely taken the place of weight limits as comfort factors in present and future transport aircraft, because hull size affects the speed and economic utilization of the craft. The coverage of greater distances calls for the provision of superior reclining chairs and sleeping accommodations. This would reduce the number of passengers and the revenue per flight. The Empire flying boat, used on the Australian route and other British long-distance airways in earlier years, was one of the most comfortable and is unlikely to be surpassed in the near future. It offered luxurious accommodations, including promenade deck and space for games. In addition to increased speed and increased distance in shorter flight time, modern aircraft promise improvement in pressurization, heating, ventilation, and reduction of noise and vibration through the use of jet and turbine-propeller engines. Meal and bar services may be less elaborate, and increased demand for "tourist" accommodations offering less luxury should permit lower fares and greater airplane utilization.

Design Considerations for the Cabin Air Conditioning System for the Boeing Stratocruiser. R. L. Linforth and M. D. Peterson. *Boeing Aircraft Company, Document No. D-7386*, December 9, 1948. 29 pp., diagrs., figs.

Design objectives for optimum passenger comfort call for ventilating rates of 40 cu. ft. per min. per passenger for removal of odors and tobacco smoke, and oxygen supply rates of 5 cu. ft. per min. per passenger at 5,000 ft. altitude, rising to 7 cu. ft. per min. at 8,000 ft. The allowable carbon dioxide concentration of 5 per cent by volume of the air within the occupied space will not be exceeded up to an altitude of 8,000 ft. when the ventilating rate is commensurate with the oxygen demand. To prevent excessive body shock for passengers stepping directly into high outside air temperature after exposure to lower cabin temperature, a cabin air temperature of 73°F. dry bulb is indicated when outside temperature is below that figure, and a proportional increase of cabin temperature to not more than 15° below ambient at 100°F. dry bulb outside temperature, with relative humidity at 50 per cent of saturated condition at the cabin dry bulb temperature. Automatic control of cabin temperature, humidity, and pressure variation is mandatory, the latter being limited to that commensurate with a rate of ascent or descent of 100 ft. per min. A pressure differential of 6.55 lbs. per sq. in. will provide sea-level cabin pressure up to 15,500 ft., and an "8,000 ft. cabin" up to 30,000 ft. airplane altitude. The combustion heating apparatus, the freon refrigeration system, and the air-recovery unit for air purifying and humidifying, all of which are described, achieved results in excess of the objectives outlined. Tables and graphs give the performance figures.

Aircraft Noise. R. L. Field, T. M. Edwards, Pell Kangas, and G. L. Pigman. *The Aeroplane*, Vol. 77, No. 2003, October 28, 1949, pp. 590, 591, figs. (Extended summary of a paper: Measurement of Sound Levels Associated with Aircraft, Highway, and Railroad Traffic.)

Making Passengers Comfortable; Designs of Aircraft Passenger Seats. *The Aeroplane*, Vol. 77, No. 2003, October 28, 1949, p. 599, illus.

Part-Pressurizing a Dakota. *The Aeroplane*, Vol. 77, No. 2000, October 7, 1949, pp. 508, 509, illus., diagr.

Education and Training (38)

Efficient Teaching Methods Will Produce Better Pilots. Arnold Warren. *Canadian Aviation*, Vol. 22, No. 11, November, 1949, pp. 25, 68, 82–84.

Electronics (3)

Short Antenna Characteristics—Theoretical. Lynne C. Smeby. *Institute of Radio Engineers, Proceedings*, Vol. 37, No. 10, October, 1949, *Waves and Electrons Section*, pp. 1185–1194, figs. 8 references.

Experimental data obtained by C. E. Smith and E. M. Johnson on short antennas top-loaded by an umbrella were analyzed mathematically. The theory developed is within practical agreement with measurements showing that, for single-tower operation, the horizontally polarized radiation is negligible. Moreover, with the optimum length of the umbrella, the vertical radiation characteristic is the same as it would be from the radiator without top loading. A refinement of the Smith-Johnson arrangements is suggested by which substantial improvement may be effected.

Streamlining "Aunt Enna." Louis R. Huber. *Boeing Magazine*, Vol. 19, No. 10, October, 1949, pp. 12–14, illus. Model airplanes with scale-sized antennas are used to obtain radiation patterns which aid in designing flush-mounted antennas to minimize drag, and to measure and correct terminal impedances of proposed antenna designs.

Diffraction of High-Frequency Radio Waves Around the Earth. M. D. Rocco and J. B. Smyth. *Institute of Radio Engineers, Proceedings*, Vol. 37, No. 10, October, 1949, *Waves and Electrons Section*, pp. 1195–1203, illus., figs. 13 references.

Report on Telemetering in Aero Research. Robert McLarren. *Aviation Week*, Vol. 51, No. 22, November 28, 1949, pp. 24, 28, 31, 32, illus.

Modern Fire Control Systems. *Plane Facts*, Vol. 6, No. 7, September–October, 1949, pp. 6–8, 18, illus.

A Rotating Goniometer for the Low-Frequency High-Power Omnirange. H. F. Keary. *U.S., Civil Aeronautics Administration, Technical Development Report No. 70*, July, 1949. 8 pp., illus., diagr., figs.

A Method of Measuring Modulation Percentage by Using an Oscillator-Mixer-Amplifier and Oscillograph. John W. Watt and Francis J. Gross. *U.S., Civil Aeronautics Administration, Technical Development Report No. 79*, June, 1949. 7 pp., illus., diagr., figs.

The Motor Uniselector and the Technique of its Application in Telecommunication. W. H. Grinsted. *Institution of Electrical Engineers, (London) Proceedings, Part III, Radio and Communication Engineering*, Vol. 96, No. 43, September, 1949, pp. 403–421, illus., diagrs., figs. 11 references.

Variations in the Dielectric Strength of Air. L. C. Aicher. *Allis-Chalmers Electrical Review*, Vol. 14, No. 3, Third Quarter, 1949, pp. 12–17, figs. 6 references. Charts and formulas for determining the effects of temperature, humidity, pressure, and density of the air, and for applying correction factors in forecasting voltages at which sparkover will occur in electrical apparatus and equipment.

Distance-Measuring Equipment for Aircraft Navigation. V. D. Burgmann. *Institution of Electrical Engineers, (London) Proceedings, Part III, Radio and Communication Engineering*, Vol. 96, No. 43, September, 1949, pp. 395–402, figs. 16 references.

The system consists of an air-borne lightweight radar set that works in conjunction with a responder beacon on the ground. The aircraft radar transmitter sends out a stream of pulses which are returned on a slightly different radio frequency by the ground beacon. Automatic circuits in the aircraft set measure the interval between the outgoing and corresponding return pulses and present the information to the pilot on a meter calibrated in miles.

Engineering Practices (49)

Differences Between the International Temperature Scales of 1948 and 1927. Robert J. Corruccini. *U.S., National Bureau*

of Standards, Journal of Research, Vol. 42, No. 2, August, 1949, pp. 133–136, fig. 2 references. Available also as Research Paper No. RP2014. U.S. Govt. Printing Office, Washington. $0.05.

CADO—Unification at Work. Albert A. Arnhym. *Aero Digest*, Vol. 59, No. 3, September, 1949, pp. 60, 132, illus.

Equipment

S.B.A.C. Display of Equipment. II. *Airports & Air Transportation*, Vol. 4, No. 76, October, 1949, pp. 245–249, illus.

Condensed descriptions of exhibits of airport and air-transport equipment, accessories, materials, and tools shown in the Static Section of the display of the Society of British Aircraft Constructors at Farnborough in September, 1949.

ELECTRICAL (16)

New Power Conversion Means Developed; Electronic Systems Replace Moving Parts in Compact Airborne Equipment. Austin N. Stanton. *Aviation Week*, Vol. 51, No. 20, November 14, 1949, pp. 29, 30, 32, 35, 36, 39, 40, illus., diagrs.

Air Interest at Radiolympia. *The Aeroplane*, Vol. 77, No. 2000, October 7, 1949, pp. 496, 497, illus.

Flight Operating Problems (31)

PILOTING TECHNIQUE

Reverse Power for Aircraft. *Shell Aviation News*, No. 135, September, 1949, p. 24, fig.

Propeller-reversing procedure developed by the Propeller Division of Curtiss-Wright Corporation has made possible the descent of a C-54 airplane at a 40° angle with a forward speed of 190 m.p.h. At a recent demonstration, the airplane was brought down from 15,000 ft. at a point 4 miles from the airport, to 1,000 ft. above the runway in 1 min., 22 sec., to land in 2 min., 55 sec., compared with 4 min., 48 sec. by conventional emergency-landing procedure.

Short-Field Landings. Robert C. Sellers. *Flying*, Vol. 45, No. 6, December, 1949, pp. 39, 54, illus.

Across the Rockies on Instruments. James Herrick. *Air Facts*, Vol. 12, No. 10, October 1, 1949, pp. 33, 36–40.

REFUELING IN FLIGHT

Aerial Pipeline. Gordon S. Williams. *Boeing Magazine*, Vol. 19, No. 11, November, 1949, pp. 3–5, illus.

A new method of in-flight refueling uses a "flying boom," essentially a telescoping pipe hinged to the tanker airplane in such a manner that it can swing horizontally or vertically. The pipe has aerodynamic controls corresponding to rudder and elevator, by which the operator can maneuver the nozzle into the refueling socket of the airplane requiring fuel supplies.

Flight Refuelling Developments; New Long-Range Responder Beacon for Aircraft Installation. *Flight*, Vol. 56, No. 2132, November 3, 1949, p. 599, illus.

Refueling a Jet in Mid-Air. *Flying*, Vol. 45, No. 5, November, 1949, pp. 20, 21, illus.

WEATHER HAZARDS

Improved Weather Service Promised by WB-CAA Tests. William D. Perreault. *American Aviation*, Vol. 13, No. 7, September 1, 1949, pp. 33, 35.

Weather-observation stations at runway ends to supplement control-tower observations, new weather-reporting procedures, a chain of volunteer observation stations, and new equipment to facilitate the transmission of reports are being tested.

All-Weather Flying. J. A. Herlihy. *Distribution Age*, Vol. 48, No. 11, November, 1949, pp. 24, 25, 43, illus.

How to Fly Around Thunderstorms. *Flying*, Vol. 45, No. 5, November, 1949, pp. 22, 23, 69–71, illus.

Flight Safety & Rescue (15)

Some Aspects of the Relationship Between Airworthiness and Safety. J. D. North. *Royal Aeronautical Society, Journal*, Vol. 53, No. 466, October, 1949, pp. 915–936, figs. 21 references.

Mathematical analytical methods are applied to the statistical estimation of the probabilities of mechanical, mental, and physical failures, and the relationship of those factors to the safety records and regulation of air-transport operations.

The Physiological Aspects of Air Safety. K. G. Bergin. *Royal Aeronautical Society, Journal*, Vol. 53, No. 466, October, 1949, pp. 937–948, diagrs., figs.

The pilot is the physiological link by which the interpretation of sensory impressions is translated into mechanical action for controlling the airplane. Vision is probably the most important faculty, requiring proficiency in both long range and short range, and good powers of convergence, fixation, and accommodation are vital for safe approaches and for assessing position, speed, and change of direction. Night vision is adversely affected by glare, lack of oxygen, smoking, alcohol, inadequate vitamin A, and fatigue. Oxygen lack decreases the range of night vision by amounts varying from 5 per cent at 4,000 ft. altitude to 35 per cent at 16,000 ft. Hearing is affected in the higher frequencies at first by the bombardment of noises in airplanes, but the effects are progressive and ultimately includes low tones. Equilibrium is affected by vision and by impulses transmitted by the otoliths and the semicircular canals in the labyrinth in the brain. Fatigue and alcohol are among the common causes of pilot error that affect safety. Cockpit and cabin design and layout can be materially improved from the physiological standpoint, while conforming as far as possible to aerodynamic and mechanical considerations.

Air Safety from the Pilot's Point of View. J. W. G. James. *Royal Aeronautical Society, Journal*, Vol. 53, No. 466, October, 1949, pp. 949–964.

Layout of control cabin and instruments, control equipment that operates smoothly and well, noise suppression, and good handling characteristics play vital parts in the safe and efficient operation of a transport airplane. Crash-proof fuel tanks should be required for all passenger-carrying craft, because the feeling of security from the danger of fire is well worth the manufacturing cost and sacrifice in pay load. The pilot must have physical comfort and mental poise if he is to succeed in flying the airplane regularly and punctually in all weather conditions. Pilots should be selected on the basis of mental equipment as well as physical fitness, and both of those qualifications should be maintained by continuous study and frequent examinations by capable instructors and flight physicians. Working conditions should be such that pilots and crew members are not subjected to excessive hours or too stringent regulations, but their individual judgment and sense of responsibility should be encouraged. Safe and successful air-line operation is based on proper handling procedures and standards on the ground and in the air.

You Can Fly Safely; An Analysis of the 1949 Fatal and Injury Cases in Pennsylvania to Date. Leighton Collins. *Air Facts*, Vol. 12, No. 11, November 1, 1949, pp. 28–55, illus.

New Edison Installation for Capital; Airline Equipping all DC-4s with Thermocouple Fire Detectors after Tests Prove them Nearly Fool-Proof. *Aviation Week*, Vol. 51, No. 22, November 28, 1949, pp. 35, 37, diagr.

Flight Testing (13)

Investigation of the Response of an Aircraft to a Finite Pulse Input. Gerhardt C. Clementson. *Massachusetts Institute of Technology, Department of Aeronautical Engineering, Thesis for Degree of Master of Science*, September 9, 1948. 145 pp., illus., diagrs., figs. 17 references.

An investigation and evaluation of a Fourier-series and a Fourier-integral method for determining the longitudinal performance operators of an airplane from the transient response to a finite pulse forcing function. A finite pulse is applied to the elevators of an aircraft and from the measured response of the system the response curve is approximated from which the performance operators are evaluated. Application of both the Fourier-series and the Fourier-integral methods to an ideal problem shows that either method can be made less inaccurate than the uncertainty level of a normal experimental determination of the system performance operators. A method of determining the system transient response to any arbitrary finite pulse is developed, which is based upon the inverse transformation of the Fourier integral and completely eliminates the use of Duhamel's integral for determining a transient response.

Correlation of the Drag Characteristics of a Typical Pursuit Airplane Obtained from High-Speed Wind-Tunnel and Flight Tests. James M. Nissen, Burnett L. Gadeberg, and William T. Hamilton. *U.S., N.A.C.A., Report No. 916,* 1948. 10 pp., illus., diagrs., figs. 3 references. U.S. Govt. Printing Office, Washington. $0.15.

Civil Test Flying; The Work and Purpose of BOAC's Development Flight. *Airports & Air Transportation,* Vol. 4, No. 76, October, 1949, pp. 251, 252.

Fuels & Lubricants (12)

The Oxidation, Ignition, and Detonation of Fuel Vapors and Gases. X—The Cause of Preignition (Surface Ignition); Undoped Liquid Fuel. XI—The Loss of Power Coincident with the Antiknock Action of the Carbonyls of Iron and Nickel in Rich Mixtures. R. O. King and Edwin J. Durand. *Canadian Journal of Research, Section F, Technology,* Vol. 27, No. 9, September, 1949, pp. 337–346; 347–358, figs. 36 references.

X. Surface ignition, or preignition, occurring during compression, is caused by partial oxidation of the fuel to aldehyde. A relatively small concentration of aldehyde is sufficient for ignition of the charge upon contact with the hot surfaces in the combustion chamber in a high-duty engine, and surface ignition may occur before or after the regular spark. Late ignition is accompanied by no destructive effect, and the engine will run without the spark, but early ignition can cause damage to the pistons and exhaust valves of supercharged engines. Experiments with rich mixtures that oxidize readily to aldehyde show that the occurrence of surface ignition then depends upon surface and mixture temperatures. Under temperature conditions chosen so as to avoid surface ignition, heptane of given composition can be used in the C.F.R. test engine at 10:1 compression ratio, the performance of acetaldehyde does not differ from that of a hydrocarbon fuel. **XI.** The increase in usable compression ratio obtained by adding iron or nickel carbonyl to rich mixtures of hydrocarbon fuel and air under the high-temperature conditions of the C. F. R. engine method of knock testing is not accompanied by a commensurate power gain. The percentage by which the observed power of the "doped" fuel was less than that obtainable from a nonknocking fuel at the same compression ratio was determined for various additions of the iron and nickel carbonyls to a commercial gasoline. The loss of possible power when using iron carbonyl in a concentration of 0.50 cu. cm. per liter ranged from 2 per cent at maximum-power mixture to more than 22 per cent at extremely rich mixtures. The loss is attributed to appreciable oxidation of the fuel prior to the completion of compression, especially when "doped" fuel is used. These experimental results confirm the theory that metallic antiknock compounds act by promoting the high-temperature surface oxidation, or heterogeneous oxidation, of hydrocarbon fuel to steam and carbon dioxide, rather than by inhibiting a homogeneous oxidation reaction by the breaking of reaction chains, as generally supposed.

Experiments on Stability of Bunsen-Burner Flames for Turbulent Flow. Lowell M. Bollinger and David T. Williams. *U.S., N.A.C.A., Report No. 913,* 1948. 6 pp., illus., figs. 4 references. U.S. Govt. Printing Office, Washington. $0.10.

The Interdependence of Various Types of Autoignition and Knock. H. Lowell Olsen and Cearcy D. Miller. *U.S., N.A.C.A., Report No. 912,* 1948. 16 pp., illus., diagrs. 11 references. U.S. Govt. Printing Office, Washington. $0.15.

Gliders (35)

Ultra Light Aircraft Association. II. *Sailplane and Glider,* Vol. 17, No. 10, October, 1949, pp. 229–233, fig.

Swedish National Contests, 1949. *Sailplane and Glider,* Vol. 17, No. 10, October, 1949, pp. 220–227, illus.

Sweden's Flying Clubs; Accent on Gliding, How the Government's Subsidy Operates, Strict Official Control. *Flight,* Vol. 56, No. 2128, October 6, 1949, pp. 478, 479, illus.

Jämin Purjelentokurssit 1949 (Jami Soaring Courses). *Ilmailu (Helsinki),* No. 3–5, 1949, p. 24. A list of this year's soaring courses at the Jamijarvi Soaring School.

Purjelennon Teoriaa; Mikä on Edullisin Lentonopeus Matkalennolla (Soaring Theory; What is the Best Speed in Cross-Country Flying)? K. J. Temmes. *Ilmailu (Helsinki),* No. 3–5, 1949, pp. 4–6, figs.

Schwedische Segelflugmeisterschaffen 1949; 6–17, Juli in Örebro (Swedish Soaring Championship 1949; at Orebro). Olle Hakansson. *Thermik,* Vol. 2, No. 9, September, 1949, pp. 143–148, illus.

Guided Missiles (1)

Supersonic Guided Missiles. I. R. E. Gibson. *American Rocket Society, Journal,* No. 78, September, 1949, pp. 129–140, 1 reference.

The Basis for the Optimum Aided-Tracking Time Constant. E. A. Mechler, J. B. Russell, and M. G. Preston. *Franklin Institute, Journal,* Vol. 248, No. 4, October, 1949, pp. 327–334, figs. 2 references.

This report explains why the optimum aided-tracking time constant for continuous signaling is between 0.2 and 0.8 sec. The general formulas for aided tracking are developed, and it is proved that with intermittent signaling the optimum aided-tracking time constant should equal the interval between signals.

Rocket to Drop Sky Eye. Volta Torrey. *Popular Science Monthly,* Vol. 155, No. 6, December, 1949, pp. 127–129, illus.

To measure radiation from the sun, earth, and sky, a steel ball, stabilized by three gyroscopes so that it will not turn more than 5°, is to be carried beyond the atmosphere by a rocket. At 60 miles altitude the ball will be ejected and cameras inside it will register the radiation detected through openings at various points in its surface. The camera will be ejected during the fall and brought to earth by a streamer parachute.

Experimental Investigations on the Sam-Control Mechanism of D 13 and Determination of the Coefficients a_v and m_v of its Control Equation According to Report A/c 71. Fredrich and Ludwig. (*Peenemunde, Heeres Versuchsstelle, A/c 86/72,* 1941.) *U.S., Air Force, Translation No. F-TS-2120-RE,* April, 1947. 15 pp., figs.

NACA Scientists Describe Year's Progress in Jet, Rocket Research. *U.S., Central Air Documents Office (Navy-Air Force), Technical Data Digest,* Vol. 14, No. 20, October 15, 1949, pp. 6–9, illus.

The Rocket Problem; New Developments Promise an Answer to an Inherent Defect—Inaccuracy. Leslie A. Skinner. *Ordnance,* Vol. 34, No. 177, November–December, 1949, pp. 184, 185, illus.

Follow the Arrow. Peter Bush. *Boeing Magazine,* Vol. 19, No. 11, November, 1949, pp. 12–14, illus.

The Boeing electromechanical computer for predicting guided-missile flight performance is based on an analogue system, and calculates such continuously varying conditions as the roll, pitch, yaw, velocity, and acceleration or deceleration. Its principle is the creation of an artificial physical system similar to that of the object being investigated. An integrator in the electronic portion of the machine is assigned to compute each possible motion through analogous alternating-current voltages based on law-of-motion formulas, and the sum of the indications represents the behavior of the missile.

Between the Lines (Ryan XAAM-A-1). James J. Haggerty, Jr. *American Aviation,* Vol. 13, No. 12, September 15, 1949, pp. 28, 29, illus.

German Missile Accelerometers. Thomas A. Moore. *Electrical Engineering,* Vol. 68, No. 11, November, 1949, pp. 996–999, diagrs., figs.

Firebird Air-to-Air Missile (Ryan Aeronautical Co., XAAM-A-1). *Aviation Week,* Vol. 51, No. 20, November 14, 1949, p. 15, illus.

The Lark (Consolidated Vultee XSAM-N-4). *Naval Aviation News,* No. 30, October, 1949, p. 13, illus.

Instruments

AIRCRAFT (9)

AGA and its Production of Aircraft Instruments. Arne Holtzberg. *Saab Sonics,* No. 8, October–December, 1949, pp. 21–24, illus., diagr.

Studio Sulla Stabilita Dinamica Longitudinale e Trasversale del Volo Pilotato Automaticamente (A Study of the Longitudinal and Transverse Dynamic Stability in Automatically Piloted Flight). L. Lazzarino. (*L'Aerotecnica,* Vol. 25, No. 2, September, 1945.) *Pisa, Universita, Facolta de Ingegneria, Pubblicazione No. 503.* 27 pp. 32 references. (Reprint.)

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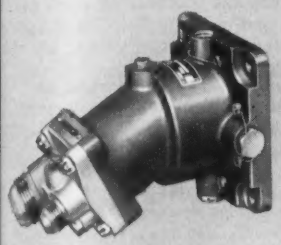

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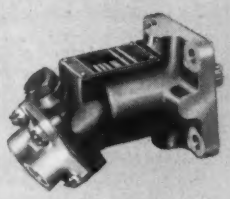

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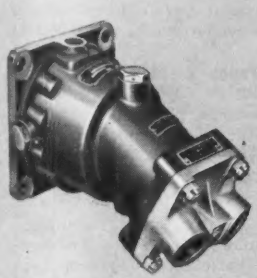

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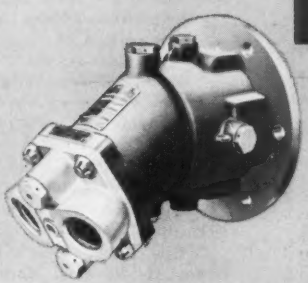

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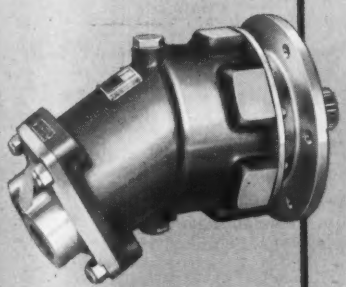

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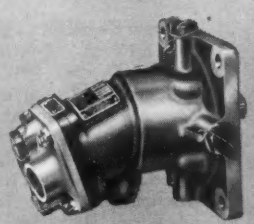

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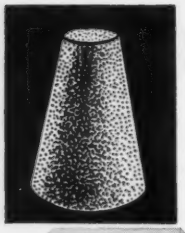

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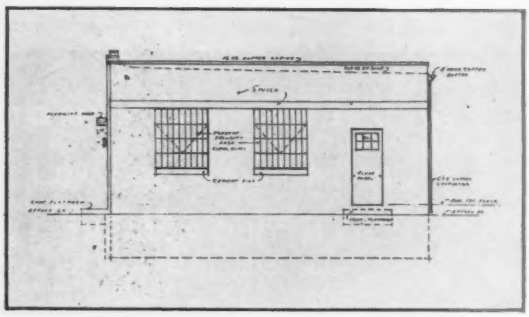

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Robot Control for XB-47's Dutch Roll; Servo Mechanism Guards Lateral Stability. Roland J. White. *Western Flying*, Vol. 29, No. 10, October, 1949, pp. 16, 17, illus., diagrs.

Instrument Shows Critical Speed; Kollsman Mach Air Speed Indicator Designed to Give Greater Operating Safety Margin on Fast Transports. *Aviation Week*, Vol. 51, No. 23, December 5, 1949, illus.

Electronic Pilots Back in Service; Three Months' Intensive Tests Result in Modifications that Airlines Believe Will Give Improved Instruments. *Aviation Week*, Vol. 51, No. 20, November 14, 1949, pp. 53, 54.

Method for Determining the Frequency-Response Characteristics of an Element or System from the System Transient Output Response to a Known Input Function. Howard J. Curfman, Jr., and Robert A. Gardiner. *U.S., N.A.C.A., Technical Note No. 1964*, October, 1949. 23 pp., diagrs., figs. 7 references.

A Radar Method of Calibrating Airspeed Installations on Airplanes in Maneuvers at High Altitudes and at Transonic and Supersonic Speeds. John A. Zalovcik. *U.S., N.A.C.A., Technical Note No. 1979*, November, 1949. 24 pp., figs. 4 references.

Readers' Forum: Note on Air-Speed Indicator Compressibility Error. Roger D. Schaufele. *Journal of the Aeronautical Sciences*, Vol. 16, No. 12, December, 1949, pp. 758, 759, figs. 4 references.

TEST & MEASURING

High-Speed Direct-Inking Recording System. Martin A. Pomerantz and Robert C. Pfeiffer. *Franklin Institute, Journal*, Vol. 248, No. 4, October, 1949, pp. 305–310, diagrs. 5 references.

A system incorporating a commercially available high-speed magnetic oscillograph is capable of resolving impulses timed at intervals of 0.01 sec. It has been used in telemetering cosmic-ray signals from balloon-borne equipment operating continuously for long periods of time. A tape-reader mechanism permits rapid analysis of results.

Consolidated Recording Oscillographs Types 5-114 & 5-115. *Consolidated Engineering Corp., Bulletin CEC-1500A.* 15 pp., illus., diagrs., figs. Operating principles, performance characteristics, and descriptions of accessories and equipment.

Optical Methods for the Determination of Flame Temperatures. I—Two-Color and Line-Reversal Techniques. S. S. Penner. *American Journal of Physics*, Vol. 17, No. 7, October, 1949, pp. 422–429. 60 references.

Optical Methods for the Determination of Flame Temperatures. II—Reversal Methods for Nonisothermal Flames, Two-Path Method, Compensated Hot-Wire Method, Methods Based on Measurements of Line Intensities. S. S. Penner. *American Journal of Physics*, Vol. 17, No. 8, November, 1949, pp. 491–500. 51 references.

Dynamic Accuracy in Temperature Measurement. J. G. Ziegler and N. B. Nichols. *Taylor Technology*, Vol. 2, No. 2, Autumn, 1949, pp. 11–16, diagrs.

Volume Dilatometry. Norman Bekkedahl. *U.S., National Bureau of Standards, Journal of Research*, Vol. 42, No. 2, August, 1949, pp. 145–156, figs. 40 references. Available also as Research Paper No. RP2016. U.S. Govt. Printing Office, Washington. $0.10.

Strain Gages for Large Plastic Strains and Combined Stresses. Joseph Marin. *American Society for Testing Materials, Bulletin*, No. 161, October, 1949, pp. 28–31, illus., diagrs. 3 references.

Operating Manual for the TMB Type 13A Strain Indicator and Associated Equipment. L. D. Anderson. *U.S., Navy, The David Taylor Model Basin, Report No. 608*, July, 1949. 22 pp., illus., figs. 3 references.

A New Instrument for the Theoretical Determination of Stress Distributions in Flat Plates of Irregular Shape (Révue Universelle des Mines, 9th Series, Vol. 5, No. 2, February, 1949, pp. 41–51). *The Engineers' Digest*, Vol. 10, No. 7, July, 1949, pp. 233–237, illus., figs.

Optical Recording Extensometer. M. Brassière. (*La Recherche Aéronautique*, No. 9, May–June, 1949, pp. 55, 56.) *The Engineers' Digest*, Vol. 10, No. 10, October, 1949, pp. 345, 346, figs.

Measurement of Small Time-Intervals Occurring in a Contact-Switching Sequence. A. Freedman. *Journal of Scientific Instruments*, Vol. 26, No. 10, October, 1949, pp. 344–348, illus., figs.

The Instron Tensile Tester. Harold Hindman and G. S. Burr. *American Society of Mechanical Engineers, Transactions*, Vol. 71, No. 7, October, 1949, pp. 789–796, illus., diagrs., figs.

Experimental Investigation of the Type-2 Multifrequency Reed Gage for Recording Shock Motion. B. J. W. Grier. *U.S., Navy, The David Taylor Model Basin, Report No. 603*, September, 1949. 27 pp., illus., figs. 6 references.

Performance of the Puget Sound Vibrograph. Quentin R. Robinson. *U.S., Navy, The David Taylor Model Basin, Report No. 693*, September, 1949. 9 pp., illus., figs.

Laws & Regulations (44)

Airport Zoning. J. Nelson Young. *Illinois, University, Urbana, Ill., Bulletin*, Vol. 46, No. 29, December, 1948. (*Institute of Aeronautics, Bulletin No. 4.*) 76 pp. 62 references.

The primary reasons for airport zoning are to prevent structural, visibility, communication, or traffic hazards in the approach space and to prevent or make unnecessary the legal obstructions to airport operation by adjacent property owners. The discussion covers governmental functions and legislative aspects, zoning ordinances, and the relationship of zoning to regional planning. Appendixes contain excerpts from various model ordinances.

IATA Operational Proposals. George C. Prill. *Aero Digest*, Vol. 59, No. 5, November, 1949, pp. 26, 27, 89, 90, 92, diagrs. Comments on the evolution and present status of performance requirements for transport aircraft, and proposals by the International Air Transport Association for modifying the regulations for climb rate and terrain clearance.

Machine Elements (14)

BEARINGS

Measurement of Oil-Film Pressures in Journal Bearings Under Constant and Variable Loads. A. Buske and W. Rolli. (*Deutsche Luftfahrtforschung, Jahrbuch*, 1937, pp. 67–78.) *U.S., N.A.C.A., Technical Memorandum No. 1200*, November, 1949. 43 pp., illus., diagrs., figs. 19 references.

FRICTION

Effect of Surface Roughness on Rolling Friction. J. J. Bikerman. *Journal of Applied Physics*, Vol. 20, No. 10, October, 1949, pp. 971–975, figs. 7 references.

Maintenance (25)

Boeing Service Guide, No. 25, October, 1949. 8 pp., illus., diagrs.

Contents: Thermal Anti-Icing Control System Flight Check. Rudder Boost Ground Check. Main Entry Door Hold-Back Mechanism. Cowl Flap Drain Holes. Fuel Cell Fastener Attachment. Modification of the Nose Gear Retracting Mechanism. Servicing Cabin Heater Fire Extinguishing System Valves. Nose Gear Door Lock Pin Installation. Door Pressure Seal Installation Procedure. Part Number Change—Hamilton Standard Circuit Breaker. Main Landing Gear Governor Plates. Fuel Shutoff Valve Gasket Replacement. Turn Engine Starting Selector Switch Off When not in Use. Revision—Control Cabin Window Heating. Exhaust Tail Pipe Ball Joint Installation.

Douglas Service, Vol. 7, No. 5, September–October, 1949. 20 pp., diagrs.

Contents: Super DC-3 Interior, DC-35. Propeller Deicing System Rework—Provides Positive Method of Deicing, DC-6. DC-6 Drain Lines, DC-6. Brake Control Valve—Test Procedure After Overhaul, DC-3. Air Conditioning System Manual, DC-6. Instrument Light—Wiring Change, DC-6. Booster Pump—Alignment of Attach Holes, DC-6. Genisco Oil Separator—For Vacuum Instrument Systems, General. Cabin Supercharger Revisions—To Increase Operating Life of Hydraulic Pumps, DC-6. Wire Coding—Number and Letter System, DC-6, DC-3S. Fuel Tank Replacements—Replacing Standard Tanks with Baffle Type, DC-3. Drain and Filler Caps—Maintenance and Improvement Changes, DC-6. Reading Light Maintenance—Adjustment Procedure, DC-6. Four Way Valves—Correct Handle Settings, DC-3. Service Bulletins, General. Solenoid Control Head, DC-6.

Maintenance by Machine. Gerard E. Nistál. *Aero Digest*, Vol. 59, No. 5, November, 1949, pp. 42, 43, 66, 68, 80, 82, illus.

Instruments and equipment for testing aircraft components and accessories are combined into stationary and portable servicing units for maintenance work on hydraulic, mechanical, electrical, fuel, and power-plant installations.

How to Keep that 'New Look'; Some Simple Checks Can Add Years to your Craft's Life. Gilbert C. Close. *Flying*, Vol. 45, No. 6, December, 1949, pp. 26, 27, 68, 69, illus.

How to Baby Your Engine. III—Altitude, Temperature and Engine Icing. Peter Altman. *Flying*, Vol. 45, No. 5, November, 1949, pp. 40, 41, 57, 58, figs.

Care and Cleaning of Windshields. M. C. Anderson and J. W. Rocke. *Flying*, Vol. 45, No. 5, November, 1949, pp. 39, 79, 82, illus.

Management & Finance (45)

Corporations' Accounts; British Airlines Incur Further Heavy Losses but Increase Capacity, Improvement Largely Dependent Upon New Aircraft. *Flight*, Vol. 56, No. 2130, October 20, 1949, pp. 532–534, figs.

British Air Corporations; Reports for 1948–49. *Modern Transport*, Vol. 62, No. 1595, October 22, 1949, pp. 9, 17.

British Airways Corporations' Accounts (1947–1949). *The Aeroplane*, Vol. 77, No. 2002, October 21, 1949, pp. 567, 568, tables.

Plane Firms Revise Dividend Plans; Policy of Putting Payments on Regular Basis is Making Air Stocks More Attractive for Conservative Investors. Selig Altschul. *Aviation Week*, Vol. 51, No. 20, November 14, 1949, p. 18.

Survey Analyzes Aviation Group; Management's Equity Holdings Appraised. Selig Altschul. *Aviation Week*, Vol. 51, No. 22, November 28, 1949, p. 17.

Capital Airlines Reports Profits from Coach Service. *American Aviation*, Vol. 13, No. 7, September 1, 1949, pp. 21, 23.

Materials (8)

METALS & ALLOYS

Effect of Chromium Plating on the Endurance Limit of Steels Used in Aircraft. Hugh L. Logan. *U.S., National Bureau of Standards, Journal of Research*, Vol. 43, No. 2, August, 1949, pp. 101–112, illus., figs. 14 references. Available also as Paper No. RP2011. U.S. Govt. Printing Office, Washington. $0.10.

Chromium plating reduced the endurance limits of both normalized and hardened (quenched and tempered) SAE X4130 steels; the reduction was larger for the hardened steel. The endurance limits for steel of a given hardness decreased with increased plating bath temperatures. Baking of the plated steel, at temperatures up to 350°C., reduced the endurance limit; baking at 440°C. increased the endurance limit of the plated steel. However (for hardened steel), baking did not restore the endurance limit to that of the unplated steel. Damaging effects of chromium on the endurance limits of plated steels are attributed to stresses in the chromium or steel, which are increased by low temperature baking but are relieved in part of baking at 400° to 440°C.

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A questionnaire on the usefulness of various aids to weather forecasting brought 1,460 replies from forecasters in the Navy, Air Force, Weather Bureau, and ten of the commercial air lines. Questions were asked about the degree of usefulness of ten selected kinds of forecast aids and ten different kinds of charts and diagrams. The replies were analyzed and tabulated on the basis of the service in which the respondents were employed and on the extent of their experience. The highest ratings in the aids category were listed as "Extrapolation based upon history," followed by "Steering of surface system along upper level flow." Greatest usefulness in the charts and diagrams category was indicated for the 700-millibar chart, favored by 95.3 per cent, with adiabatic diagrams taking second place at 92 per cent of the respondents. Analysis revealed further that differences in the opinions of the various services are minor and are attributable mainly to differences in requirements and data availability. Only small variations were found on the basis of experience and training of the respondents. Discrepancies were found between the usefulness of a particular aid and the extent to which it was used.

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Reports on the functions, responsibilities, achievements and contributions to progress, of public and private agencies concerned with aviation. Written by prominent members and key executives of those organizations, the reports outline the history, development, accomplishments and objectives of those units. The public agencies represented include the United States Senate, House of Representatives, and various Federal Government departments and bureaus. The private agencies include scientific, trade, and management associations and state aviation bureaus.

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ROCKET (4)

Creation of High-Pressure Gas Source for Rocket-Motor-Propellant Supply Systems. C. J. Turansky and R. D. Rinehart. *American Rocket Society, Journal*, No. 78, September, 1949, pp. 99–103, illus., diagrs., fig.

A liquified-gas evaporator and a dry-gas pressure booster were developed to provide a simple and portable high-pressure gas supply that is free from contamination and moisture. The first unit is a high-pressure sphere that is filled with liquid nitrogen from a commercial source. The liquid flows to the bottom of the heat exchanger, boils off and leaves the exchanger as a gas of 0°F., whence it flows to a manifold for distribution. The approximate evaporation rate is one gallon per min., which produces 87.5 cu. ft. of pollution-free gas at standard temperature and pressure, and allows a storage sphere of 1.5 cu. ft. to be charged to 5,000 lbs. per sq. in. in six min. The second unit is a portable oil-free dry-gas helium pressure booster that uses commercial valves, tubing, and accumulators, and requires minimum maintenance. Gas delivered into the bladder of the accumulator is compressed by oil pressure generated by an external pump. A large unit charges a one cu. ft. sphere to a final pressure of 4,000 to 5,000 lbs. per cu. in.

Organization for Rocket-Engine Development. Bernard Pearlman. *Aero Digest*, Vol. 59, No. 5, November, 1949, pp. 20–22, 64, diagrs. 6 references. Suggested functional layout for an engineering and research department and an outline of the duties and responsibilities of the project engineer and his assistants.

JET & TURBINE (5)

Potentialities and Development Problems of the Turboprop Engine. M. J. Zucrow. *American Rocket Society, Journal*, No. 78, September, 1949, pp. 116–128, figs. 14 references.

Studies of the relative efficiencies of the gas turbine and its applications in the form of the turbojet and the turboprop power plant are based on the effects of pressure loss, turbine-inlet temperature, net output, thermal efficiency, altitude effects, and machine efficiency. The future of the turboprop engine is closely related to the development of more efficient compressors, turbines, and means for operating with higher turbine-inlet temperatures. For each one per cent of improvement in turbine efficiency, the cycle efficiency will be raised three per cent. Metallurgical advancements have been great and further progress is indicated, but utilization of turbine-inlet temperatures of the order of 2,000 to 3,000°F. must be based on successful methods for cooling the blades and discs. Both centrifugal and axial-flow compressors have merit, and a combination of the two forms may be the solution of the problem of higher pressure ratios. For aircraft speeds in the 400 to 500 m.p.h. range, the turboprop engine has made substantial progress. Its flexibility, high thermal efficiency, low weight, and small frontal area are advantages that can be improved still more by development of higher inlet temperatures, high cycle pressure ratios, and machine efficiency.

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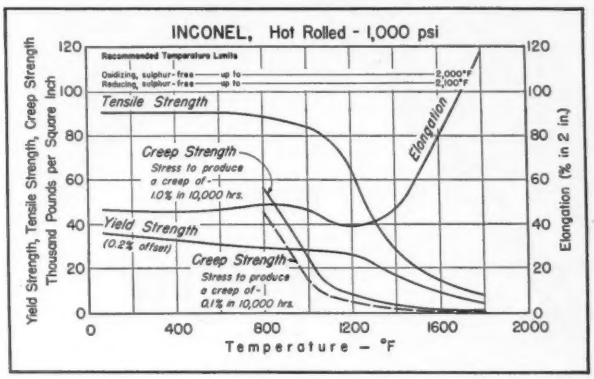

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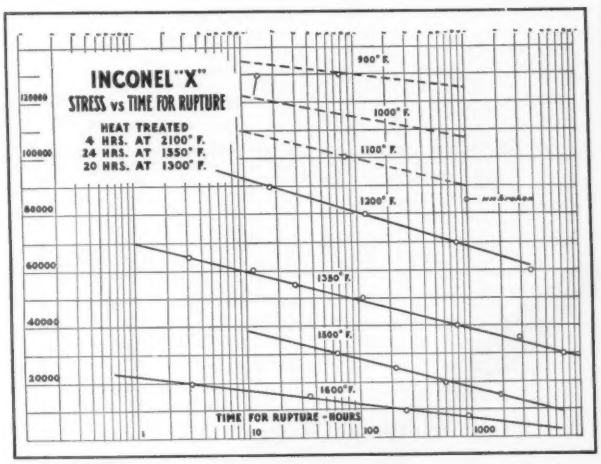

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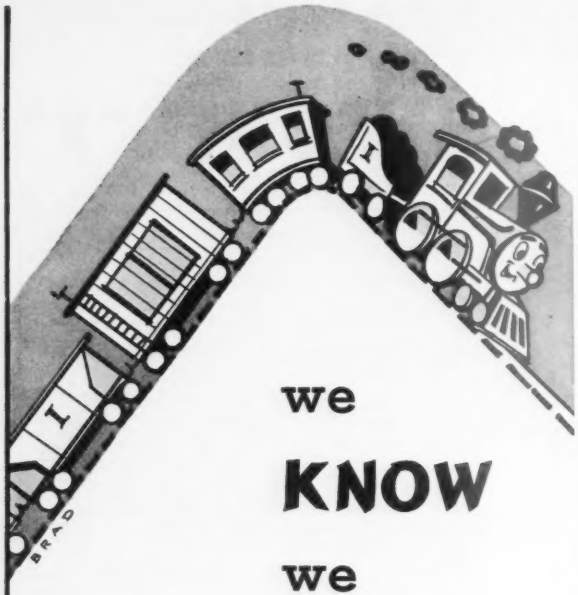

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The Effect of Altitude Conditions on Fuels for Aero Gas Turbines. M. O'Farrell. *Shell Aviation News*, No. 135, September, 1949, pp. 16–20, figs.

Four fuels suitable for gas turbines were evaluated from the standpoints of air evolution, boiling and evaporation loss, water and ice separation, freezing, humidity effects, and explosion risks. These fuels were aviation kerosene, wide-range distillate JP.2 and JP.3, and aviation gasoline. Tests were made at altitudes up to 45,000 ft., temperatures ranging from −60°C. to 80°C., and were made also for evaporation, vapor evolution, vapor pressure, and explosive limits. Kerosene was selected for commercial use, because of its high flash point to reduce fire risks, and because the evaporation losses of more volatile fuels would be uneconomical. Provision for keeping the fuel warm is desirable for temperatures below −40°C., and methyl alcohol injection will prevent filter icing down to that point. For military aircraft, the more volatile fuels required will have freezing points below −60°C., so that filter clogging by wax is possible only under extreme conditions. Vapor evolution is the chief problem with the distillates, but reversion to the less volatile JP.2 type would be a solution.

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RECIPROCATING (6)

Crankshaft Damping. P. Draminsky. *Institution of Mechanical Engineers, Proceedings, Applied Mechanics, Vol. 159, War Emergency Issue No. 46*, 1948, pp. 416–424, Discussion, pp. 424–432, illus., figs. 4 references.

Experiments with an externally driven single-cylinder oil engine excited to torsional vibrations by a spring-loaded cam disc facilitated the investigation of separate moving parts, and showed that damping was almost entirely due to hysteresis in the crankshaft and to oil damping caused by lateral shaft movements that are directly proportional to the clearance in the main and crankpin bearings. Methods are given for the calculation of damped vibrations in arbitrary elastic systems, of hysteresis and bearing damping in a single-cylinder engine, as well as formulas for calculating total damping in multicylinder engines, with or without heavy flywheels. Results are compared with measured damping of engines in service.

Fuel Injection. E. A. Smith. *Aeronautics*, Vol. 21, No. 6, November, 1949, pp. 92, 95, 96, figs.

Comments on the problems encountered and the solutions found in the development and application of fuel pumps, nozzles, governors and other parts of the fuel-injection system for reciprocating and turbine engines.

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Developments and Improvements in Spark Plug Manufacture. Karl Schwartzwalder. *Ohio, State University, Engineering Experiment Station News*, Vol. 21, No. 4, October, 1949, pp. 29, 30, 48, 49, diagr., references.

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Piston Ring Movement During Blow-By in High-Speed Petrol Engines. P. de K. Dykes. *Institution of Mechanical Engineers, Proceedings, Part II, Automobile Division*, 1947–48, pp. 71–78, Discussion, pp. 78–83, illus., diagrs., figs. 3 references.

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Quarterly Bulletin. *Aeronautical Laboratories, National Research Council of Canada, Report No. ME 1949 (3)*, July 1–September 30, 1949. 26 pp., illus., figs.

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The Helicopter Gets Around. Alexander Klemin. *Aero Digest*, Vol. 59, No. 5, November, 1949, pp. 44, 45, 64, 66, illus. Review of recent applications of helicopters for sports, fishing, land surveying and mapping, and brief descriptions of several new designs of rotating-wing aircraft and engines for operating them.

An Introduction to the Physical Aspects of Helicopter Stability. Alfred Gessow and Kenneth B. Amer. *U.S., N.A.C.A., Technical Note No. 1982*, November, 1949. 35 pp., figs. 6 references.

Longitudinal Flying Qualities of Several Single-Rotor Helicopters in Forward Flight. F. B. Gustafson, Kenneth B. Amer. C. R. Haig, and J. P. Reeder. *U.S., N.A.C.A., Technical Note No. 1983*, November, 1949. 25 pp., illus., diagrs., figs. 7 references.

Helicopter Economics; A Survey of Rotary-Wing Potential in Terms of Profit and Loss. *Flight*, Vol. 56, No. 2128, October 6, 1949, pp. 474, 475. (Extended summary of a paper.)

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Sciences, General (33)

MATHEMATICS

On a New Method of Solving Certain Variational Problems of Mathematical Physics. Walter Ritz. (*Journal für der Reine und Angewante Mathematik (Crelle)*, Vol. 135, 1903, pp. 1–61.) *Australia, Council for Scientific and Industrial Research, Division of Aeronautics, Translation No. 1*, June, 1943. 50 pp. 7 references.

A general solution for the problem of determining the deformation of an originally flat elastic plate of given shape clamped all around under specified normal forces. The method is applied to the well-known Dirichlet problem and to ordinary differential equations with variable coefficients that originate from variational problems, where the values of the integral and possibly some derivatives are prescribed. The application of the method of a vibrating string shows that even in cases where the convergence proof breaks down, the method remains useful numerically, and is suitable for the determination of Chladni's figures.

The Application of Non-Integral Legendre Functions to Potential Problems. R. N. Hall. *Journal of Applied Physics*, Vol. 20, No. 10, October, 1949, pp. 925–931, figs. 7 references.

There are a number of important potential problems having axial symmetry and involving a conical boundary whose solutions require the use of zero-order Legendre functions of real but non-integral degree. The numerical evaluation of such problems is relatively simple once the zeros of these functions have been determined and when certain integrals have been evaluated. This paper presents tables and curves giving this information, together with a number of approximate expressions for these quantities. A number of potential distributions involving conducting cones, spheres, and rings are worked out to illustrate the application of these functions.

On Nonlinear Partial Equations with Two Independent Variables. Richard Courant and Peter Lax. *Communications on Pure and Applied Mathematics*, Vol. 2, Nos. 2, 3, June-September, 1949, pp. 255–273, figs. 7 references.

On Linear Partial Differential Equations with Analytic Coefficients. Fritz John. *Communications on Pure and Applied Mathematics*, Vol. 2, Nos. 2, 3, June-September, 1949, p. 209–253, fig. 21 references.

Note on Approximating Complex Zeros of a Polynomial. Bernard Friedman. *Communications on Pure and Applied Mathematics*, Vol. 2, Nos. 2, 3, June-September, 1949, pp. 195–208. 3 references.

Two Matrix Methods for Calculating Forcing Functions from Known Responses. Bernard Mazelsky and Franklin W. Diederich. *U.S., N.A.C.A., Technical Note No. 1965*, October, 1949. 36 pp., figs. 1 reference.

Equations for the Approximate Solution of Dynamic Problems for Stable Linear Systems. Kurt H. Hohenemser. *Journal of the Aeronautical Sciences*, Vol. 16, No. 12, December, 1949, pp. 723–728, figs. 2 references.

Structures (7)

Principles of Optimum Structural Design as Applied to Aircraft Weight Analysis. F. R. Shanley. *Douglas Aircraft Company, Inc., Project Rand, No. RA-15069*, February 27, 1948. 47 pp., figs. 11 references.

Optimum weight of structural members that fail by buckling is a function of the properties of the material, the magnitude and kind of the load, and the size and proportions of the member. The effects of load and size may be combined into what is called a "structural index," that controls the allowable stress for a given material, and which in turn controls the weight. Examples are worked out for simple tubular columns, various sheet-stiffener combinations, panels with simply supported edges, cylindrical shells, and stiffened shells. The material properties that directly affect the weight are determined analytically, and a comparison is made of several alloys of magnesium, aluminum, and steel. Even the most elementary weight formulas can be improved by adopting a two-parameter method, in which only part of the primary structural weight is assumed to be affected by the loading conditions and proportions of the structure.

A Structural Test Frame with Automatic Loading. F. W. Page and J. C. King. *Royal Aeronautical Society, Journal*, Vol. 53, No. 466, October, 1949, pp. 997–1008, illus., diagrs., figs.

To meet the need for testing under combined vertical, lateral, and torsional loads, and to provide a degree of portability so that the unit might be moved if required, a U-frame design was selected that does not call for a reinforced floor. Maximum overall dimensions are 84 ft. long, 34 ft. wide, and 29 ft. high. Maximum loads specified are 140 tons distributed load per side frame, 200 tons vertical load at central anchorage, and 300 ton-ft. torsional moment reacted by end frame. Each loading unit comprises a box-section weighbeam pivoted near one end and mounting the straining gear at the other end, and supported on a hydraulic load-measuring capsule. Power is provided by a 2 hp., two-speed electric motor. By positioning the capsule relative to the pivot, a selected portion of the load on the straining rods is transmitted to the guided vertical spindle of the capsule and reacted by hydraulic pressure on the under side of a diaphragm. To keep the ratio between the loads on the individual units constant the capsules are positioned so that their distances from the weighbeam pivots

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Fatigue Tests with Stress Cycles of Varying Amplitude. G. Wallgren. *Flygtekniska Forsoksanstalten (The Aeronautical Research Institute of Sweden), Meddelande Nr. 28,* 1949. 34 pp., figs. 14 references. 3.50 Kr. (In English.)

Fatigue tests of unnotched sheet specimens, specimens notched by drilled holes and riveted-joints of specimens 24S-T, 75S-T, Alclad, and Cr-Mo-steel were made using stress cycles of varying amplitude. The load spectra represented stresses caused by gust and maneuvering loads of aircraft wings. The theoretical life time of the elements was calculated according to the cumulative damage theory, which assumes failure to occur when the sum of all part damages equals unity. The ratio between the fatigue life obtained experimentally and the calculated lift was computed in order to obtain an expression for the real sum of all part damages at failure. The magnitude of this sum appears to depend on the mean stress level of the element, the load spectrum, and the type and material of the element. Although the hypothesis that failure occurs when the sum of all the damage reaches unity is a useful approximation, those loads within the load spectrum which are smaller than the endurance limit appear to have a weakening effect on the aluminum alloys tested. On the average their life time increased 20 per cent when the loads smaller than the endurance limit were excluded in the fatigue tests.

Determination of Fatigue Life with Stress Cycles of Varying Amplitude. S. Luthander and G. Wallgren. (*Flygtekniska Forsoksanstalten, Meddelande Nr. 18.*) *Stockholm, Kungl Flygforvaltiningen (Royal Swedish Air Board), Translation No. 10,* 1949. 20 pp., figs. 16 references. (In English.)

A method for computing the fatigue life of a structure subjected to fatigue load with variable stress limits. Calculations were made for alclad sheets, with and without notches, subjected to a load-time function that was assumed to correspond roughly to the load variations on an aircraft flying in gusty weather. Plots of the calculated fatigue life showed good agreement with experimental data.

The Motion and Deformation of Aircraft in Uniform and Non-Uniform Atmospheric Disturbances. J. R. M. Radok and Lurline F. Stiles. *Australia, Council for Scientific and Industrial Research, Report No. ACA-41,* July, 1948. 37 pp., figs. 31 references.

A theory for flexural and torsional deformations of an aircraft flying in turbulent air. The two cases treated correspond to a symmetrical uniform gust and to an asymmetrical gust, neglecting the Wagner effect in both cases. Integral-differential equations are obtained for the curvature and angle of twist of the wing, for the vertical acceleration, the angle of pitch and of roll (in the asymmetrical case) at the center of mass of the aircraft. In contrast to former investigations, acceleration records taken in flight are used to specify the atmospheric conditions, making it feasible to determine actual gust velocities based on reliable physical data and to demonstrate the small effect of wing flexibility on the acceleration at the c.g., subject to the assumptions made. An approximating method is developed for the solution of the governing equations, which enables the investigation of any accelerometer record, provided a fundamental set of computations has been established. The theory is applied to the case of a typical four-engined aircraft, and the records are analyzed for one fairly complicated acceleration and several simple accelerations. The solutions agree well with experimental results and are given in the form of time records.

Elastic Buckling of Outstanding Flanges Clamped at One Edge and Reinforced by Bulbs at Other Edge. Stanley Goodman. *U.S., N.A.C.A., Technical Note No. 1985,* October, 1949. 25 pp., figs. 9 references.

Stresses in and General Instability of Monocoque Cylinders with Cutouts. VII—Experimental Investigation of Cylinders Having Either Long Bottom Cutouts or Series of Side Cutouts. N. J. Hoff, Bruno A. Boley, and Joseph J. Mele. *U.S., N.A.C.A., Technical Note No. 1962,* October, 1949. 57 pp., illus., figs. 6 references.

Data on the Compressive Strength of 75S-T6 Aluminum-Alloy Flat Panels Having Small, Thin, Widely Spaced, Longitudinal Extruded Z-Section Stiffeners. William A. Hickman and Norris F. Dow. *U.S., N.A.C.A., Technical Note No. 1978,* November, 1949. 23 pp., illus., figs. 14 references.

Curved Web Y-Section Configuration Evolved as High Efficiency Panel Member in Series of NACA Tests. Robert McLarren. *Aviation Week,* Vol. 51, No. 17, October 24, 1949, pp. 29–31, figs. 4 references.

Shear Distribution in Beams with Variable Webs. B. E. Gatewood. *Journal of the Aeronautical Sciences,* Vol. 16, No. 12, December, 1949, pp. 749–753, figs. 1 reference.

Critical Stress of Ring-Stiffened Cylinders in Torsion. Manuel Stein, J. Lyell Sanders, Jr., and Harold Crate. *U.S., N.A.C.A., Technical Note No. 1981,* November, 1949. 17 pp., figs. 7 references.

The Elastic Twist of Straight Wings. Walter Boccius. *U.S., Central Air Documents Office (Navy-Air Force), Technical Data Digest,* Vol. 14, No. 20, October 15, 1949, pp. 13–23, figs. 8 references.

Two-Spar Wing Stress Analysis; A Method Taking Into Account the Finite Spacing of the Ribs, with Detailed Numerical Calculations and Test Results for a Model Wing Test Specimen. II. W. J. Goodey. *Aircraft Engineering,* Vol. 21, No. 249, November, 1949, pp. 358–362, illus., figs.

Two-Spar Wing Stress Analysis; A Method Taking Into Account the Finite Spacing of the Ribs. W. J. Goodey. *Aircraft Engineering,* Vol. 21, No. 248, October, 1949, pp. 313–319, figs.

A Method to Determine the Change in Flutter Speed Due to Small Changes in the Mechanical System. A. I. van de Vooren. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1366,* 1947. 4 pp. 2 references. (In English.)

A method for evaluating the influence on flutter speed of minor structural changes in the airplane, without performing another complete flutter calculation. The objective is attained by the application of common perturbation methods to the system of linear, homogeneous, algebraic equations, containing definite modes of deformation, which represent the basis of the original flutter calculation.

The Change in Flutter Speed Due to Small Variations in Some Aileron Parameters. A. I. van de Vooren. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1380,* 1947. 6 pp., figs. 3 references. (In English.) Diagrams of the change in flutter speed caused by small variations in aileron static balance, aileron moment of inertia, ratio of aileron chord to total chord, and the position of the aileron hinge axis.

The Application of the Statistical Theory of Extreme Values to Gust-Load Problems. Harry Press. *U.S., N.A.C.A., Technical Note No. 1926,* November, 1949. 43 pp., figs. 14 references.

Summary of Information Relating to Gust Loads on Airplanes. Philip Donely. *U.S., N.A.C.A., Technical Note No. 1976,* November, 1949. 145 pp., illus., diagrs., figs. 44 references.

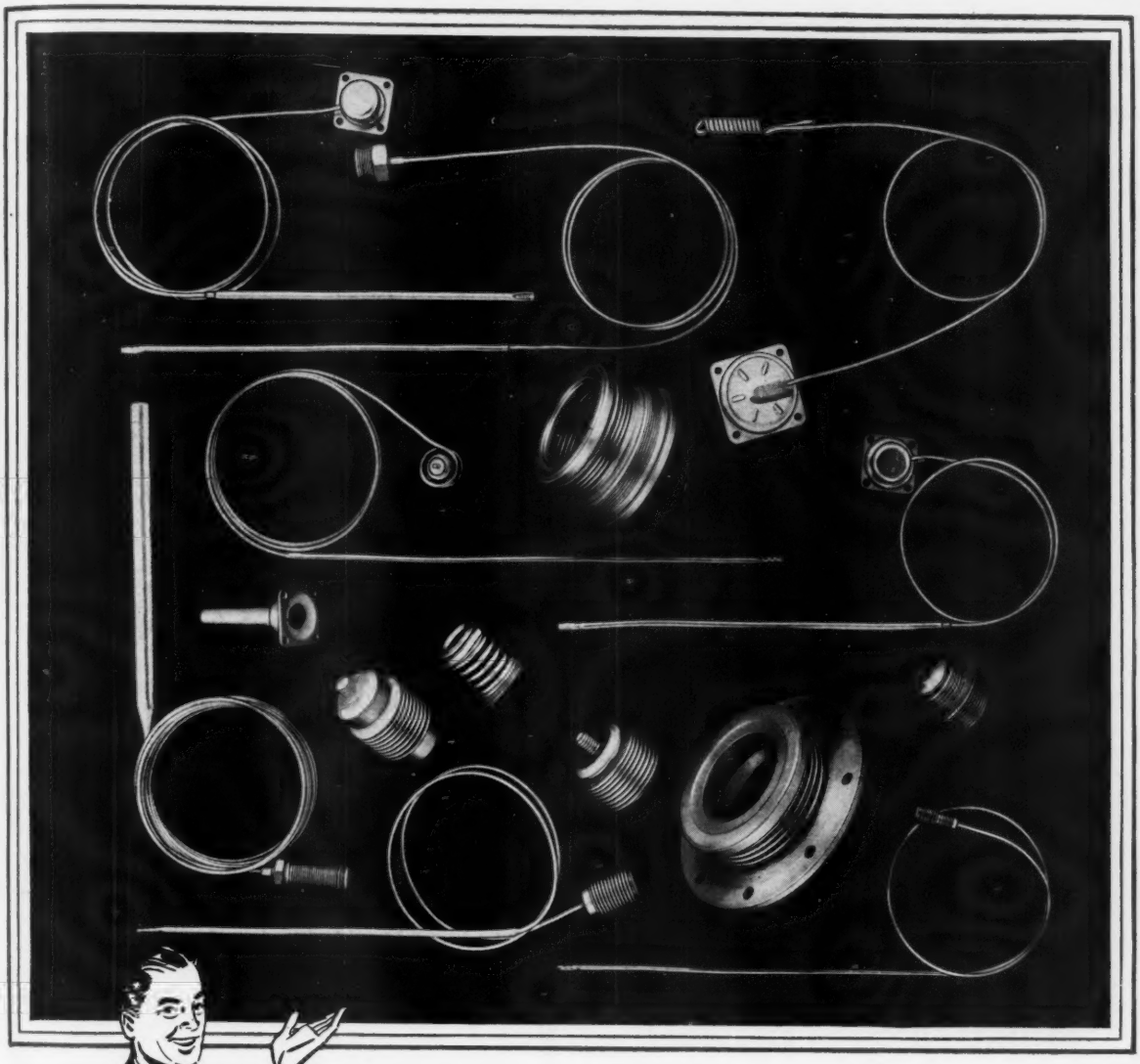
Influence of Wing Flexibility on Force-Time Relation in Shock Strut Following Vertical Landing Impact. Albert E. McPherson, J. Evans, Jr., and Samuel Levy. *U.S., N.A.C.A., Technical Note No. 1995,* November, 1949. 41 pp., illus., diagrs., figs. 12 references.

Plastic Buckling of Extruded Composite Sections in Compression. Elbridge Z. Stowell and Richard A. Pride. *U.S., N.A.C.A., Technical Note No. 1971,* October, 1949. 15 pp., figs. 4 references.

Plastic Stress-Strain Relations. W. M. Shepherd. *Institution of Mechanical Engineers, Proceedings, Applied Mechanics, Vol. 159, War Emergency Issue No. 39,* 1948, pp. 95–99, Discussion pp. 99–114, illus., diagrs., figs.

The author derives stress-strain relations that are applicable to problems in which the elastic and plastic strains are of comparable magnitude. Two alternative criteria are used, one based on the Mises-Hencky function and the other on the maximum shear stress. Shear stress-shear strain curves are deduced from tensile stress-strain curves and the results are in one case compared with experiment. The problem of a thin tube strained in tension beyond the onset of plasticity and then subjected to an increasing torque is considered, and the tensile and shear strains due to the torque are found. A result relating to the energy lost in plastic straining is obtained.

The Plastic Behaviour of Solids. I. II. Andrew McCance. *The Engineer,* Vol. 188, Nos. 4893, 4894, November 4, 11, 1949, pp. 529–531; 546, 547, figs. 9 references.



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Static Failure and Fatigue of Steels with Particular Reference to Welded Structures. I. M. Roš. *Sheet Metal Industries*, Vol. 26, No. 271, November, 1949, pp. 2417–2426, 2440, figs.

Fatigue Strength of Fillet-Weld, Plug-Weld, and Slot-Weld Joints Connecting Steel Structural Members. Wilbur M. Wilson, William H. Munse, and Walter H. Bruckner. *Illinois, University, Bulletin*, Vol. 46, No. 68, May, 1949. (*Engineering Experiment Station Bulletin, Series No. 380.*) 104 pp., illus., diagrs., figs.

NLR Hydraulic Static Testing Apparatus. J. K. Haviland and G. F. W. McCaffrey. *Canada, National Research Council, Report No. MM-213*, March 15, 1949. 16 pp., illus., diagrs. Description of the apparatus used for static strength testing of aircraft components and other large structures, and of the hydraulic loading equipment and the "tension patch" method used to transmit loads to the test specimen.

A 1000-Ton Horizontal Structure-Testing Machine. I. *The Engineer*, Vol. 188, No. 4895, November 18, 1949, pp. 576–579, illus.

Detailed description of a machine designed for a Ministry of Supply establishment for full-scale testing of aircraft box sections, panels, struts, joints, and wing and fuselage sections up to 30 ft. 3 in. long and 4 ft. 6 in. deep, under compression and tension. Under full load a bending moment of 3,000 ton-inches and a shear force of 50 tons can be exerted by a moving ram crosshead to which are coupled five rams and cylinders. Each of the four hydraulic cylinders of the straining crosshead is designed for pressure of 3,360 lb. per sq. in.

Thermodynamics (18)

The Design of Contra-Flow Heat Exchangers. Ernst Schmidt. *Institution of Mechanical Engineers, Proceedings, Applied Mechanics, Vol. 159, War Emergency Issue No. 44*, 1948, pp. 351–356, Discussion, pp. 357–362, figs. 11 references.

A method of calculation for contra-flow heat exchangers, for gases at turbulent flow, where the essential dimensions are given as functions of the initial design conditions and the properties of the fluid. The analogy between heat transfer and friction is used, and to make the analogy more evident, another nondimensional heat-transfer coefficient is introduced. That number may be used instead of the Nusselt number for describing heat transfer in tubes, and in similar problems. The conditions for minimum weight and volume are derived, and the main dimensions of the apparatus are given in formulas based on the intended heat exchange, the total temperature drop, the total energy loss, and the properties of the fluid. The weight and total volume of the heat exchanger depend upon the ratio of temperature drop and energy loss on both sides of the heat exchanging surface.

Thermal Properties of Wind-Tunnel and Jet-Engine Gases. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 33, No. 11, November, 1949, pp. 127, 128.

A project established at the National Bureau of Standards with the cooperation of the Navy Bureau of Aeronautics calls for the preparation of tables of 13 different thermal properties for each of 13 gases, and three of the tables are now available for general distribution. Properties to be tabulated as functions of both temperature and pressure are heat capacity at constant pressure, enthalpy, entropy, Gibbs free energy, compressibility, relaxation parameters, viscosity, density, specific-heat ratio, sound velocity, thermal conductivity, Prandtl Number, and vapor pressure, covering a range of pressure up to 100 atmospheres and from low temperature up to 3,000° absolute. Tables are in loose-leaf form with descriptions, directions for use, an evaluation of the basic data, and estimates of accuracy.

Heat Transfer to Liquid Metals Flowing in Asymmetrically Heated Channels. W. B. Harrison and J. R. Menke. *American Society of Mechanical Engineers, Transactions*, Vol. 71, No. 7, October, 1949, pp. 797–803, figs. 12 references.

Heat Transfer to Water at High Flux Densities With and Without Surface Boiling. Frank Kreith and Martin Summerfield. *American Society of Mechanical Engineers, Transactions*, Vol. 71, No. 7, October, 1949, pp. 805–815, illus., diagrs., figs. 25 references.

Temperature Gradients and Eddy Diffusivities in Turbulent Fluid Flow. Robert J. McCarter, Leroy F. Stutzman, and How-

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ard A. Koch, Jr. *Industrial and Engineering Chemistry*, Vol. 14, No. 6, June, 1949, pp. 1290–1295, diagrs., figs. 13 references.

The Image Orthicon in Spectroscopy. R. E. Benn, W. S. Foote, and C. T. Chase. *Optical Society of America*, Vol. 39, No. 7, July, 1949, pp. 529–532, illus., diagrs. (Reprint.)

Combustion Studies with the Orthicon Spectrograph. J. T. Agnew, R. G. Franklin, R. E. Benn, and A. Bazarian. *Optical Society of America, Journal*, Vol. 37, No. 5, May, 1949, pp. 409, 410, illus. (Reprint.)

Readers' Forum: Heat Source in a Uniform Flow. H. S. Tsien and Milton Beilock. *Journal of the Aeronautical Sciences*, Vol. 16, No. 12, December, 1949, p. 756.

Thermodynamic Properties of Air at High Temperatures. J. O. Hirschfelder and J. L. Magee. *U.S., Atomic Energy Commission, Technical Information Division, Oak Ridge, Tenn., Document No. MDDC-590*, January 1, 1947. 49 pp., tables.

Water-Borne Aircraft (21)

Preparation of Data for Computation of Vertical Flexural Modes of Hull Vibration by Digital Process. Alice W. Mathewson. *U.S., Navy, The David Taylor Model Basin, Report No. 632*, September, 1949. 12 pp., figs. 1 reference.

A method for calculating the flexural modes of hull-vibration by digital computation while a surface ship is still in the preliminary design stage. The computation is based on the solution of a set of linear difference equations obtained by dividing the hull into 20 sections from stern to bow. Quantities involving the relationship of the mass of the ship sections and of the surrounding water, the section dimensions, the variable moment of inertia of the cross section, the shear modulus of elasticity, and the ratios of the shear stresses of the structural steel material are tabulated, and the difference equations are applied to each section. The method is at present recommended only for the preparation of data on vertical modes.

Hydrodynamic Research Plans Future "Flying Fleet." Ernest G. Stout. *Western Flying*, Vol. 29, No. 10, October, 1949, pp. 14, 15, illus.

Fleets of water-based bombers, interceptors, transports, tankers, and cargo carriers are visualized as future naval airpower units that will help in solving problems of intercontinental range and heavy bomb pay load. By utilizing the 76 per cent of the earth's surface that is covered by water, many of the limitations of runway, length, carrier size, and other difficulties of land-based or shipboard operations can be overcome. Hydrodynamic research aided by dynamically-similar powered seaplane models is making possible the development of such supersonic, world-ranging, water-based aircraft.

Ships and Flying-Ships; Ocean Liner and Marine-Aircraft Development Compared. L. G. Griffiths. *Flight*, Vol. 56, No. 2134, November 24, 1949, pp. 664–667, illus., figs.

Tests of Twenty Related Models of V-Bottom Motor Boats E.M.B. Series 50. Kenneth S. M. Davidson and Anthony Suarez. *U.S., Navy, The David Taylor Model Basin, Report No. R-47*, March, 1949. 103 pp., diagrs., figs.

Effect of Forebody Warp and Increase in Afterbody Length on the Hydrodynamic Qualities of a Flying-Boat Hull of High Length-Beam Ratio. Walter J. Kapryan. *U.S., N.A.C.A., Technical Note No. 1980*, November, 1949. 36 pp., illus., diagrs., figs. 7 references.

Flight Tests of the Hydrodynamic Characteristics of a Japanese "Emily" Flying Boat. J. A. Ferguson, R. E. Seibels, Jr., and R. J. Corber. *U.S., N.A.C.A., Technical Note No. 1968*, September, 1949. 33 pp., illus., diagrs., figs. 6 references.

Experimental Method for Determining the Virtual Mass for Oscillations of Ships. J. J. Koch. (*Ingenieur- Archiv, Vol. 4, Part 2, pp. 103–109.*) *U.S., Navy, The David Taylor Model Basin, Translation No. 225*, May, 1949. 9 pp., figs.

A Method for Converting the British © Coefficient Based on the Froude "O" Values to a © Coefficient Based on the Schoenherr Formula. Morton Gertler. *U.S., Navy, The David Taylor Model Basin, Report No. 657*, June, 1949. 7 pp., figs.

Wind Tunnels (17)

A Method for the Continuous Variation of the Mach Number in a Supersonic Wind Tunnel and Some Experimental Results Obtained at Low Supersonic Speeds. G. Drougge. *Flygtekniska Forsoksanstalten (The Aeronautical Research Institute of Sweden) Meddelande Nr. 29*, 1949. 14 pp., illus., diagr., figs. 3 references. 1.50 Kr. (In English.)

The method uses an ordinary nozzle to obtain a fixed supersonic velocity and then varies the velocity by means of a movable wedge. The investigation comprised measurements on Schlieren pictures of a small conical tip in the test section, where Mach Numbers between 1.45 and 1.04 were obtained. For a two-dimensional double circular arc wing model of 8 per cent thickness, the drag and lift coefficients were determined at Mach Numbers between 1.44 and 1.12, and Schlieren pictures were taken. For investigations in the upper transonic range the method may be useful, especially as a substitute for the more complicated and more expensive flexible-wall tunnel equipment. At very low Mach Numbers, that is, less than 1.10, it may be difficult to obtain good velocity distribution in the test section, but since the model must be small at those Mach Numbers a moderate velocity gradient may be accepted. Comparison of the results obtained with other available data supports the assumption that the method is reliable.

Wind Tunnel Interference on Rolling Moment of a Rotating Wing. P. Mandl and J. R. Pounder. *Canada, National Research Council, Report No. MA-216*, June 10, 1949. 37 pp., figs. 8 references.

Formulas for the interference correction to the rolling moment of a rotating wing in a circular wind tunnel. The analysis takes into account the helical path of the trailing vortices. Numerical results for an open tunnel give the variation of the correction factor with the rate of rotation for various taper ratios, lift distributions, and wing-span to tunnel-diameter ratios. As the rate of rotation increases, the interference decreases, but is more affected by the lift distribution; at all rates of rotation the correction factor decreases with taper and increases rapidly with the span-diameter ratio.

Maryland Tunnel. *The Pegasus*, Vol. 14, No. 5, November, 1949, pp. 6, 7, illus. Description of the subsonic wind tunnel being built at the University of Maryland. It will provide a top-wind velocity of 350 m.p.h. in the 7 × 9 × 11 ft. test section and permit use of model wing spans of 8 or 9 ft.

Model Missiles Shot Through Giant Tube; The Navy's Pressurized Spark Range Acts Like Wind Tunnel in Reverse, Air Stands Still, Models Fly Through It. John F. Loosbrock. *Popular Science Monthly*, Vol. 155, No. 6, December, 1949, pp. 145–147, illus.

Measurement of Intensity of Turbulence in Water by Dye Diffusion. M. S. Macovsky, W. L. Stracke, and J. V. Wehausen. *U.S., Navy, The David Taylor Model Basin, Report No. 700*, July, 1949. 22 pp., illus., diagrs., figs. 6 references.

Note on Two-Dimensional Supersonic Tunnel Interference. W. F. Hilton. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2332*, December 30, 1943. 6 pp., figs. 2 references. British Information Services, New York. $0.35.

Preliminary Measurements of the Boundary Layer in the 11-in. Supersonic Wind Tunnel. W. F. Cope and G. G. Watson. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2304*, August, 1946. 7 pp., figs. British Information Services, New York. $0.40.

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Aeronautical Reviews

Books

Airplane Performance, Stability, and Control

By Courtland D. Perkins and Robert E. Hage. New York, John Wiley & Sons, Inc., 1949. 493 pp., illus., diagrs. $7.00.

This book is a welcome addition to the textual material for students of aerodynamic design. It has been the goal of the authors to bridge the gap between the study of aerodynamic fundamentals and the application of these fundamentals to aircraft design. Toward this goal they have made very considerable progress.

The book has two major divisions, the first dealing with the classical performance problem and the second with aircraft flying qualities. A brief introductory chapter serves to outline the relationships between the traditional elements of equilibrium performance, static stability and control, and dynamic stability and control response.

The performance problem is dealt with in three chapters, entitled "Drag Estimation," "Propulsion," and "Airplane Performance." In the first of these chapters a groundwork consisting of a condensed review of aerodynamic fundamentals is laid. The chapter is then extended to the development of empirical methods for the estimation of airplane drag in various speed ranges. In the second chapter various types of propulsion systems, including propeller, turboprop, turbojet, ramjet, and rocket are studied from the standpoint of efficiency and performance in relation to speed and altitude. In the third chapter the classical performance problem and such special problems as range, endurance, and take-off are considered. Both graphical and analytical solutions to the former are discussed either in terms of power or thrust.

The scope of the second division, dealing with airplane flying qualities, is evident in the chapter headings: "Static Longitudinal Stability and Control Stick-Fixed," "Static Longitudinal Stability and Control Stick-Free," "Maneuvering Flight," "Directional Stability and Control," "Dihedral Effect and Lateral Control," "Longitudinal Dynamics," and "Lateral Dynamics." In the first of these chapters the contributions of various components of the airplane to longitudinal stability, including power effects, are discussed quantitatively in detail, and control power requirements are considered for various equilibrium flight conditions. In the following chapter these results are modified for the stick-free condition, and control design is dealt with on the basis of stick-force limitations and feel. In each case the results are finally interpreted in terms of allowable c.g. travel for a given configuration. Maneuver points and "stick force per g" in steady pull ups or turns are taken up in the third chapter to conclude the topic of longitudinal static stability and control.

Static directional stability and control and rolling stability and control are considered in the following two chapters as essentially separate topics, although in each case the coupling effects on control design requirements are discussed.

In the last two chapters the airplane equations of motion are set up in the classical manner and solutions are considered for uncontrolled motions with either locked or free controls and for response to prescribed control manipulations.

From the standpoint of material presented the book resembles a modernized version of Diehl's "Engineering Aerodynamics." However, in the present work the authors have placed considerably greater emphasis upon the logical and detailed development of equations and formulas than did Diehl.

The point of view is continually that of preliminary design. Although the reader is frequently cautioned regarding the extent to which estimations can be trusted, the methods of determining ultimate flight characteristics do not always imply a lack of faith in their validity. For instance, in analysis of performance the effects of Mach Number on the drag characteristics of a given airplane are never explicitly introduced. Instead, the methods presented involve the use of low speed drag data for speed calculations, with subsequent application of corrections based on generalized estimates of compressibility effects as a function of wing thickness and C_L.

Throughout the second division of the book, a list of suggested references, including technical reports and papers, is given at the end of each chapter. In view of the tremendous volume of published material of this type and the difficulties experienced by the researcher in sorting out items of interest, the student should find these reference lists to be of considerable value indeed. It is somewhat curious, however, that this commendable practice was not followed in the section dealing with performance.

Although it is almost inevitable, in view of the subject matter, the practicing engineers will find cases in which their own methods do not agree with those presented here, the authors are to be congratulated on their generally excellent handling of the subject. The book is almost certain to find wide usage both as a textbook and as an engineering reference.

FRED H. FELBERG
Lecturer in Aeronautics
California Institute of Technology

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Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

Principles of Aerodynamics

By James H. Dwinnell. New York, McGraw-Hill Book Company, 1949. 390 pages, illus., $5.50.

During the past several years it has been very pleasant to see a number of good new and revised books on aeronautical engineering make their appearance. It becomes a pleasure to welcome one more to the growing list: *Principles of Aerodynamics* by Professor James H. Dwinnell of the University of Washington.

The scope of *Principles* is approximately that necessary and expected for a basic textbook on aerodynamics. There are important chapters on Fluid Dynamics, Airfoils, Wing Planforms, Viscosity, Compressibility, Power Plants, Propellers, Performance, and Stability and Control plus several lighter chapters for general student broadening. The value of the book stems not from the reasonable scope but from the depth and thoroughness of the coverage and the unusual strength of the arguments. The exceptions to the simplified "rules" and formulas are clearly and forcefully stated, limitations are opportunely given, and upon occasion

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parallel examples in other familiar fields are used as illustrations.

There is also a refreshing degree of originality throughout the book; in figures, presentations, symbols, and problems. In a great number of instances, simple proofs have been removed from the text and appear as problems, which they rightfully are, and to save instructors the time and effort of problem work the separate answer book ($0.25 per copy) has the significant steps as well as the final answer. And, too, the problems in general are a far cry from the substitute-in-a-formula type.

There is only one subject that this reviewer found missing in *Principles*—a method of ascertaining the spanwise distribution of lift. This can, of course, be provided by the instructors, if felt necessary and class time allows.

In the opinion of this reviewer the book will make itself felt strongly during the next few years. It should be adopted by a large number of schools and thus be a benefit to the industry as a whole. In addition, it is felt that many practicing engineers would enjoy and benefit from reading over *Principles* in order to review the fundamentals and get caught up on new developments.

ALAN POPE
Associate Professor
Daniel Guggenheim
School of Aeronautics
Georgia Institute of Technology

Achievements of Modern Science

By Dr. A. D. Merriman. London, W.C.1, The Gregg Publishing Co., Ltd., 1949. 284 pp., illus., diagrs. 21*s*.

The writing of a book on a scientific subject for the purpose of enlightening intelligent, but not necessarily technically trained people is always a difficult task. If the objective is to produce a treatise that will be interesting to both the scientist and the layman, the author has to be a trained educator and a gifted writer, and he must possess a deep knowledge of the subject. Dr. Merriman has all these attributes and, in addition, his style and method of graphic presentation are superb.

Achievements of Modern Science contains 284 pages, 220 diagrams, and 28 half-tone plates, all of absorbing interest. It is divided into ten chapters more or less independent of one another. Practically every chapter has a historical introduction; thus Chapter I, "Rockets," gives, among other chronological data, a Chinese legend dealing with this artifice. The chapter then explains the development of mortars, and next explains the development of land and air rockets, both liquid and solid-fueled. It ends with an analysis of the V-2 rocket. Chapter II, "Space Travel," is a fascinating speculation on the question whether or not, with present-day knowledge, a manned trip to the moon and back is possible.

Chapter III, "Atomic Energy," is one of the clearest explanations of modern theories pertaining to the structure of the atom and present and future uses of nuclear physics in its application to industry and warfare. This chapter is also enlivened with interesting, little-known historical facts. The sketches and charts are original and so clear that they undoubtedly will make the comprehension of nuclear physics possible even for the layman.

Chapter IV deals with thermionic valves (called tubes in America). This chapter, and the two following it are particularly recommended for reading by mechanical engineers who so often are not aware of the unlimited uses to which the thermionic tube can be applied. Chapter V is a review of the manifold uses of tubes—as the author calls it, "putting electrons to work." Logically, "Radar," Chapter VI, comes next and, here again, the substitution of plain English for the "gobbledegook" so frequently encountered in popular technical literature as a substitute for sound thinking, and the inclusion of simple line drawings makes understanding of this latest aid to navigation a matter of course.

Chapter VII describes the electron microscope and the author shows diagrammatically, side by side, the optical microscope and the electronic one and the similarity and dissimilarity of the two devices with the special advantages and limitations of each immediately become apparent.

"Earth Magnetism and Degaussing," Chapter VIII, while good reading, appears to the reviewer to be somewhat too elementary in comparison with the preceding material, but the valuable historical comments largely mitigate this seeming inconsistency.

The ninth chapter leaves the electrical field and deals with propellers. Here, again, Dr. Merriman shows that he is a fine popularizer. The functioning of the propeller is explained without recourse to either the momentum or blade element theory. The author confines his explanations to pure geometry and does it in such a way that one can apply his analytical method both to propulsive and lifting propellers.

The last chapter, "Controlling the Weather," gives the history of meteorology and explains critically the many attempts at making rain or snow.

Achievements in Modern Science should be a welcome book to any educated person. In particular it should be on the shelves of student counselors, scientific writers and engineers. The officer, be he in the Air Force, Navy, Engineers, or Signal Corps, will greatly profit by reading it. The book should be required reading in classes of technical English as it is a model in logic, style, and clarity.

It takes courage to undertake a work like this. One is not surprised that Dr. Merriman did so, since he merely matched his intellectual prowess with his wartime record which deservedly brought him one of the few George Crosses to be awarded in the late war. The many American Technical Intelligence Officers, including this reviewer who had the privilege of working with Dr. Merriman during that conflict, congratulate him and his publisher on a fine book excellently produced.

DR. STEPHEN J. ZAND
Vice-President—Engineering
Lord Manufacturing Company
Erie, Pa.

Analysis and Lubrication of Bearings

By Milton C. Shaw and E. Fred Macks. New York, McGraw-Hill Book Co., 1949. 618 pp., illus., diagrs. $10.

It is gratifying that Messrs. Milton C. Shaw and E. Fred Macks undertook to assemble in this book the latest information on bearing developments and related subjects. The text covers the classical bearing theories without choking the chapters with complicated and highly academic mathematical derivations. Only the important mathematical steps to best illustrate the points in question are given, since an excellent bibliography makes available all the pertinent references for those who find it desirable to review the equations presented. Differential and integral calculus, and an elementary knowledge of mechanics and hydrodynamics seem to be the minimum needs for the reader.

Following an interesting introduction, two valuable chapters cover in considerable detail general bearing load analyses, including the more complex loads found on aircraft engine bearings, both piston and gas turbine type. Because the loads on piston engine bearings, in particular those acting on the main crankpin and wrist pin bearings, are constantly changing in magnitude and direction they are difficult to evaluate. The major portion of the chapters is given to analysis of this type of load. A separate chapter is devoted to dimensional analysis. This useful mathematical tool for the solution of problems in mechanics, which do not lend themselves to exact mathematical solution, is presented in sufficient detail to give the reader a working knowledge of the principles involved.

The chapter on hydrodynamic lubrication is undoubtedly the key chapter in the book. Here, Petroff's equation and Reynolds' differential equation for the pressure developed in an oil film are derived and these principles applied to the plane-slider bearing, which illustrates well the load capacity of a wedge-shaped film. The chapter also covers other hydrodynamic lubrication factors such as slider-bearing friction, pivot location, and full journal bearing operation. Subsequent chapters in the hydrodynamic field are concerned in fundamental analysis of dynamically loaded bearings, journal bearings, hydrodynamic thrust bearings, as well as high-speed journal bearing factors such as variations of viscosity across the oil film, turbulence in the oil film, oil film whirl, bearing erosion, and cavitation.

The chapter on rolling-contact bearings presents in general terms the basic principles of load capacity, friction, and fatigue life of these bearings. Lubrication of these bearings is very lightly discussed and the reader tends to feel, wrongly, that lubrication of this type of bearing is not a problem. An interesting analysis of boundary layer considerations, including surface roughness analysis, types of metals, and their properties and characteristics, is given in a separate chapter. The concluding chapter describes and shows performance data for a number of bearing test machines used by various investigators to obtain the data presented throughout the book. Numerous problems at the end of the text cover all the important principles presented and should give the student ample opportunity to test his knowledge of the subject matter. A bibliography of references is included.

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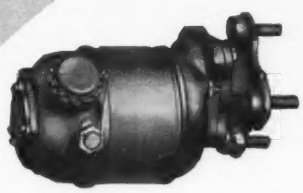

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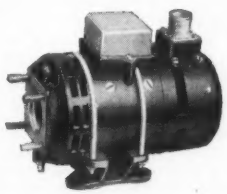

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On the whole, the book represents a very well-organized collection of many scattered contributions on hydrodynamic bearing theory, and should be a very useful book, both as a reference for the engineer in industry and as a text for the student in engineering.

JOHN B. ACCINELLI
Shell Development Company
Emeryville, Calif.

Book Notes

AIR TRANSPORTATION

National Transportation Policy. Charles L. Dearing and Wilfred Owen. Washington, D.C., The Brookings Institution, 1949. 459 pp., diagrs. $4.00.

This book is based in part on a study of federal transportation activities undertaken by the authors at the request of the Hoover Commission on government reorganization. Programs and agencies for the promotion and regulation of all forms of transportation are reviewed in the first two parts of the book, covering 350 pages. The final parts deal with conflicts and inconsistencies in the existing setup, a review of past reorganizations and proposals, a proposed Department of Transportation, incorporating coequal offices of water, highway, and railroad transportation, civil aviation, and a transport regulatory commission. Statistical data on highway, railway, air, and inland waterway transportation, and airports; résumés of federal activities performing ancillary services for transportation, and proposals for reorganizing national transportation activities are included in appendixes. This is a well documented and organized review of the problem, calling attention to the need for federal reorganization geared to the technological advances in transportation made in the past several decades, and to the significance of the problem for national security and a sound economy.

AIRPLANE DESIGN & DESCRIPTION

Airplane Design, a Textbook on Airplane Layout and Preliminary Design Calculations with Emphasis on the Economics of Design. Karl D. Wood. 9th Edition. Boulder, Colorado, University Bookstore, November, 1949. 376 pp. (Lithographed), illus., diagrs. $6.00.

This new edition of Professor Wood's textbook, last revised in September, 1947, contains 40 additional pages, including additions and changes in the text on the layout design of high speed airplanes and on structural design considerations. In the appendixes, additions are included on performance charts and data, power plants, and applied loads and strength data from ANC-5a, *Strength of Metal Aircraft Elements*. The parts of *Civil Air Regulations*, Part 3, pertaining to aircraft design, are reproduced in an appendix. A new example is worked out for a supersonic airplane design, and new sketches and illustrations for design and layout have been added from recent publications on such developments as the castering landing gear.

ENGINEERING PRACTICES AND AIDS

Technical Sketching and Visualization for Engineers. Hyman H. Katz. New York, The Macmillan Company, 1949. 163 pp., illus., diagrs. $5.00.

This book is intended as a text and reference on technical sketching for students of engineering drawing, and for draftsmen and engineers. It is stated to be the first such guide to the various types of technical sketching now used in industry. Both the methods of sketching and the uses of sketching are discussed in detail, based on the author's experience as an instructor in aircraft drafting and design engineer, with Republic Aviation Corporation, Consolidated Vultee Aircraft Corporation, The University of Texas, and at present, the Allied School of Mechanical Trades in Chicago.

EQUIPMENT

ELECTRICAL

Learning Electricity and Electronics Experimentally. Leonard R. Crow. Vincennes, Indiana, The Scientific Book Publishing Company, 1949. 525 pp. illus., diagrs. $4.40.

The purpose of this book is to cover electricity generally from the experimental point of view, as an aid to the student in understanding the fundamental laws governing magnetic and electrical phenomena. The first part deals with elementary problems, presented in 75 experiments, with diagrams and illustrations of the apparatus. The second part covers advanced problems. Emphasis is placed largely upon the qualitative aspects of the experimental procedures. Mathematics is limited to a minimum of simple arithmetical calculations.

Saturating Core Devices, Operating Principles and Applications. Leonard R. Crow. Vincennes, Indiana, The Scientific Book Publishing Company, 1949. 373 pp., illus., diagrs. $4.20.

As this book is intended to acquaint the elementary student with electric phenomena, information on which is not conveniently collected elsewhere, it makes use of descriptive and graphic methods, and mathematics is kept to a minimum. The book offers a collection of simplified descriptions of saturable-core devices and applications, including both electronic and nonelectronic applications, covering a.c. and d.c. saturable-core reactors, the permanent-magnet-controlled saturable-core reactor, peaking transformers and voltage waveforms, a.c. voltage regulators applying magnetic regulation, saturable-core frequency-multiplier apparatus, flux gates, saturable-core-type servomechanisms, and magnetic amplifiers.

MATERIALS

The Story of Magnesium. W. H. Gross. Cleveland, Ohio, American Society for Metals, 1949. 258 pp., illus., diagrs. $2.00.

This book is intended as a readily understood description of the history, occurrence and technology of magnesium, including methods of production, alloying, melting and refining, casting, fabrication, machining, joining, surface finishing, physical metallurgy, and its various uses. The purpose of the book is admirably fulfilled, and it is an excellent introduction to the subject.

PRODUCTION

How to Cut Production Costs, a Guide to Better Methods and Techniques. Edited by H. E. Blank, Jr. New York, Funk & Wagnalls Company, in association with *Modern Industry Magazine*, 1949. 384 pp., illus. $4.50.

A survey is presented of the best industrial practice on modern production methods, techniques and equipment, plant maintenance, services, and working conditions. Pointers on the control of obsolescence in plant and equipment, materials handling, cost controls, quality control, inspection costs, reduction of damage, and packing and shipping costs are included in the first section. Better fabrication techniques, new aids in processing, and the uses of electronic controls, x-rays, cameras, radioisotopes, and other scientific aids to production are included in the second section. Newer techniques such as lost-wax art casting, high-frequency heating, infra-red drying and baking, and subzero cold treating are included with recent improvements in welding and other operations. The final section deals with plant maintenance, waste, accident prevention, noise, vibration, lighting, and other conditions affecting the efficiency of personnel.

REFERENCE LITERATURE

Glossary of Aeronautical Terms. (British Standard 185; Part 2: 1949). London, S.W.1, British Standards Institution, 1949. 22 pp. 3s

This part of the glossary, dealing with terms on aircraft power plants, propellers, and hydraulic, pneumatic, and electrical equipment, is issued in advance of Parts 1 and 3, in order to make available a standard terminology in gas turbines and jet propulsion. Definitions of over 325 terms are given.

DICTIONARIES & ENCYCLOPEDIAS

International Civil Aviation Organization. Lexicon of Aeronautical Terms (Preliminary Draft). (Appendix to Document C-WP/337.)

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SCIENCES, GENERAL

MECHANICS

Seventh International Congress of Applied Mechanics, London, 1948. Proceedings. South Kensington, London, S.W.7, Organising Secretary, VIIth International Congress of Applied Mechanics, Imperial College, 1949. 4 vols. with 6 illus., diagrs. £5.00 per set.

Introduction. 124 pp. Le tenseur spectral de la turbulence homogene non isotrope dans un fluide incompressible, J. Kampé de Fériet. Recent developments in turbulence research, G. K. Batchelor. The present state of development of experimental stress analysis, M. Hetényi. Recent developments in the mathematical theory of plasticity (abstract) W. Prager. Complete list of published papers. Members of Congress.

V.I. 432 pp. I.1. A new theory of elasticity and strength, H. Brandenberger. I.2. Sur le principle de Saint-Venant, K. Brim. I.3. Finite elastic deformations, L. M. Milne-Thomson. I.4. Sur le calcul de la deformation d'un solide elastique encastre, M. Picone. I.5. Severe deformations, K. H. Swainger. I.6. A theory of the transition from tough to brittle fracture with special reference to velocity effects in impact testing, W. Lethersich. I.7. Prestressed spiral reinforcement, W. Olszak. I.8. Some synthetic theorems of elasticity and of mathematical physics: Their developments from the practical point of view; three methods of successive approximations, L. Broglio. I.9. A method of "equivalence" applied to the solution of problems of elasticity and of mathematical physics, L. Broglio. I.10. On the torsion of shafts of revolution, A. Weinstein. I.11. Evaluation of stresses and strains in axially loaded compressive specimens, G. Murphy. I.12. The conjugate frame as a tool for evaluating deflections, G. Murphy. I.13. Plane state of stress studied by use of a physical grid, L. E. Grinter. I.14. The influence of its own weight on the stability of a rectangular plate, H. Favre. I.15. The bending of a compressed continuous plate, W. Nowacki. I.16. Experimental investigation of the post-buckling behaviour of flat plates loaded in shear and compression, A. van der Neut. I.17. Strength of sandwich panels, J. Lockwood Taylor. I.18. Some investigations on the Euler instability of flat sandwich plates with simply-supported edges, F. J. Plantema. I.19. On the cooperation of two cantilever spars with a shear-resisting skin, J. Naleszkiewicz. I.20. A general solution for the bending of beams on an elastic foundation of arbitrary continuity, M. Hetenyi. I.21. The strength of wooden box beams, J. P. O. Silberstein, J. R. M. Radok, and H. A. Wills. I.22. Tall building structures under wind load, L. Chitty and Wen-Yuh Wan. I.23. Photoelastic investigation of the stress concentration caused by surface irregularities, A. F. C. Brown and V. M. Hickson. I.24. Instability in hollow rubber

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Artificial Radioactivity. P. B. Moon. Cambridge and New York, Cambridge University Press, 1949. 102 pp., diagrs. $2.50.

The purpose of this volume is to outline the principle phenomena and techniques of radioactivity, bearing in mind particularly the reader wishing to take into account the recent literature, including some references of 1948. While the radioactive properties of a good many individual nuclei are discussed as illustrations, a complete list is considered outside the scope of the book.

The Adsorption of Gases on Solids. A. R. Miller. Cambridge and New York, Cambridge University Press, 1949. 133 pp., diagrs. $2.50.

This book is based upon *Some Problems in Adsorption* (1939), by J. K. Roberts. The revision includes material on phenomena as described by new statistical theories instead of the previous empirical methods, including the behavior of immobile films, the effect of dipole-dipole, and van der Waals' interactions; and the continuous variation of the potential field provided by the adsorbing surface. About half the book consists of new material, and the remainder has been rewritten to conform. The purpose of the book is to survey the present state of knowledge on the subject.

The Nature of Physical Theory. P. W. Bridgman. New York, Dover Publications, 1949. 138 pp. $2.25. This is a reprint of Dr. Bridgman's three Vanuxem lectures delivered at Princeton University in December, 1935, and first published in this expanded form in 1936.

Surface Tension and the Spreading of Liquids. R. S. Burdon. 2nd Edition. Cambridge and New York, Cambridge University Press, 1949. 92 pp., illus., diagrs. $2.50.

This new edition of a work first published in 1940 accounts for work published in recent years and retains the purpose of the original in stating the position of the subject as known today. Chapters are included on The Nature of Surface Forces; Measurement of Surface Tension; The Surface of Liquid Metals: Mercury; Spreading: General Conditions; Spreading on the Surface of

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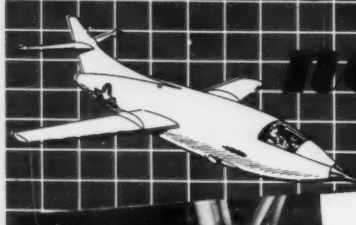

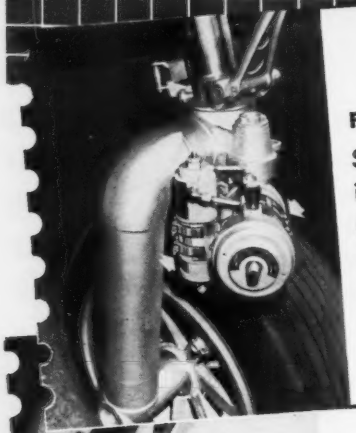

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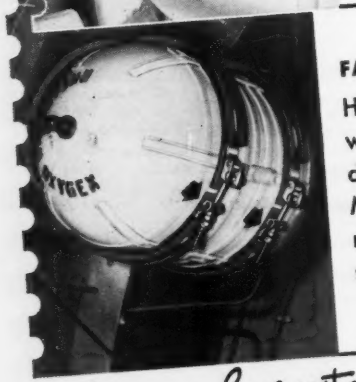

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The Physical Principles of the Quantum Theory. Werner Heisenberg. Translated by Carl Eckart and Frank C. Hoyt. (Chicago, 1930). New York, Dover Publications, Inc., 1949. 184 pp., illus., diagrs. $2.50.

A reprint of the translation of Professor Heisenberg's lectures at the University of Chicago, first published in 1930, which summarize his own and other investigators' contributions to the new theory of quantum mechanics. The mathematical apparatus of the quantum theory is discussed separately, in an appendix of about 80 pages.

THERMODYNAMICS

Third Symposium on Combustion and Flame and Explosion Phenomena, published under the auspices of The Standing Committee on Combustion Symposia. Baltimore, The Williams and Wilkins Company, 1949. 748 pp., illus., diagrs. $13.50.

Flame Stabilization and Quenching. 1. The Stability of Open Flames. Kurt Wohl, Numer M. Kapp, and Carl Gazley. 2. Flame Stabilization and Propagation in High Velocity Gas Streams. Glenn C. Williams, Hoyt C. Hottel, and A. C. Scurlock. 3. Flame Stabilization by Baffles in a High Velocity Gas Stream. J. P. Longwell, J. E. Chenevey, W. W. Clark, and E. E. Frost. 4. Some Experimental Techniques to Investigate the Mechanism of Flame Stabilization in the Wakes of Bluff Bodies. H. M. Nicholson and J. P. Fields. 5. Theory of Ignition, Quenching and Stabilization of Flames of Nonturbulent Gas Mixtures. Guenther von Elbe and Bernard Lewis. 6. Burning Velocities, Quenching, and Stability Data on Nonturbulent Flames of Methane and Propane with Oxygen and Nitrogen. Application of Theory of Ignition, Quenching, and Stabilization to Flames of Propane and Air. Margaret E. Harris, Joseph Grumer, Guenther von Elbe, and Bernard Lewis. 7. Application of Dimensionless Numbers to Flash-Back and Other Combustion Phenomena. Abbott A. Putnam and Randolph A. Jensen. 8. The Mechanism of Flash-Back of Aerated Flames. J. S. Forsyth and J. E. Garside. 9. The Structure and Stability of Diffusion Flames. D. A. Scholefield and J. E. Garside. 10. The Quenching of Laminar Oxyhydrogen Flames by Solid Surfaces. Raymond Friedman.

Flame Propagation in Explosive Gas Mixtures. 11. Theory of Propagation of Flames. Part I—General Equations. J. O. Hirschfelder and C. F. Curtiss. 12. Theory of Propagation of Flames. Part II—Approximate Solutions. M. J. Henkel, W. P. Spaulding, and J. O. Hirschfelder. 13. Theory of Propagation of Flames. Part III—Numerical Integrations. M. J. Henkel, H. Hummel, and W. P. Spaulding. 14. The Role of Free Atoms and Radicals in Burner Flames. Charles Tanford. 15. Theories and Phenomena of Flame Propagation. J. J. Broeze. 16. Studies on Hydrogen-Bromine Flames. Howard R. Garrison, James A. Lasater, and Robbin C. Anderson. 17. Interaction of Flame Propagation and Flow Disturbances. G. H. Markstein. 18. A Study of High Velocity Flames Developed by Grids in Tubes. Marjorie W. Evans, Milton D. Scheer, Louis J. Schoen, and E. L. Miller. 19. The Effect of Turbulence on Flame Speeds of Bunsen-Type Flames. David T. Williams and Lowell M. Bollinger. 20. Factors Affecting Flame Propagation Through Dust Clouds. H. M. Cassel, A. K. Das Gupta, and S. Guruswamy. 21. Influence of Molecular Structure of Hydrocarbons on Rate of Flame Propagation. Thaine W. Reynolds and Melvin Gerstein. 22. Burning Velocities in Ethylene-Air Mixtures. J. W. Linnett and M. F. Hoare. 23. A Study of Burning Velocity. G. W. Culshaw and J. E. Garside. 24. Inflammability of Mixtures of Cyanogen and Air. Influence of Humidity. Paul Laffitte and Guy Pannetier. 25. Aerodynamical Effects of Heat Release by Combustion of Steadily Flowing Gases. Bruce L. Hicks. 26. Unsteady One-Dimensional Flows with Heat Addition or Entropy Gradients. A. Kahane and Lester Lees.

27. The Burning Velocity of Gases in Relation to the Ignition Delay Period. R. F. Strickland Constable. 28. Development of a Combustion Wave in a Flowing Gas. Robert J. Dery. 29. Electrical Properties of Flames. Burner Flames in Transverse Electric Fields. Hartwell F. Calcote.

Flames of Fuel Jets. 30. Diffusion in Laminar Flame Jets. H. C. Hottel and W. R. Hawthorne. 31. Mixing and Combustion in Turbulent Gas Jets. W. R. Hawthorne, D. S. Weddell, and H. C. Hottel. 32. Diffusion Flames. Kurt Wohl, Carl Gazley, and Numer Kapp.

Ignition of Gas Mixtures. 33. The Ignition of Gas Mixtures by Impulsive Pressures. W. C. F. Shepherd. 34. The Ignition of High Velocity Streams of Compressible Gases by Heated Cylindrical Rods. James W. Mullen, II, John B. Fenn, and Moreland R. Irby. 35. The Ignition of Gaseous Explosive Media by Hot Wires. H. P. Stout and E. Jones. 36. The Spark Ignition of Nitrous Oxide-Hydrogen Mixtures. J. W. Linnett and Miss D. M. Nutbourne. 37. The Incendivity of Electric Sparks in Relation to the Characteristics of the Circuit. G. Allsop and E. M. Guénault. 38. Effect of Gas Stream Parameters on the Energy and Power Dissipated in a Spark and on Ignition. Clyde C. Swett, Jr. 39. Ignition of Gas Mixtures by Electric Sparks. Humbert Morris. 40. Ignition of Explosive Gas Mixtures by Electric Sparks. III. Minimum Ignition Energies and Quenching Distances of Mixtures of Hydrocarbons and Ether with Oxygen and Inert Gases. M. V. Blanc, P. G. Guest, Guenther von Elbe, and Bernard Lewis.

Kinetics and Mechanism of Combustion Reactions. 41. Processes in the Vapor Phase Oxidation of Ether, II. G. H. N. Chamberlain and A. D. Walsh. 42. Processes in the Vapor Phase Oxidation of Ethers, III. G. H. N. Chamberlain and A. D. Walsh. 43. The Atomic Hydrogen-Molecular Oxygen Reaction and Hydrocarbon Oxidation Initiated by Atomic Hydrogen at Low Pressures. Elmer J. Badin. 44. Oxidation of Metal Alkyls and Related Compounds. The Ignition of Hydrocarbons. Elmer J. Badin. 45. Some Aspects of the Combustion of Methane at Low Pressures. A. J. Everett and G. J. Minkoff. 46. Researches on the Combustion of Mixtures of Normal Pentane and Oxygen between 250° and 350°C. M. Prettre. 47. The Two-Stage Process in the Combustion of Higher Hydrocarbons and Their Derivatives. Kate Spence and D. T. A. Townend. 48. The Oxidation of Hydrocarbons. Cecil E. Boord. 49. Reactions of Adiabatically Compressed Hydrocarbon-Air Mixtures. W. Jost. 50. The Mechanisms of Some Elementary Reactions Occurring in Flames. I. Carbon Monoxide Flame. Virginia F. Griffing and Keith J. Laidler. 51. The Determination of Radical Concentrations and Reactivities in Chemical Reactions. H. W. Melville. 52. Chemical and Spectroscopic Evidence for the Free Radical Methylene CH_2. Paul Goldfinger, Pierre Le Goff, and Maurice Letort. 53. The Capture of Gas-Phase Free Radicals with Organic Free-Radical Reagents. Frederick Benington. 54. The Oxidation of Sulphur Dioxide in Combustion Processes. G. Whittingham. 55. The Mechanism of the Oxidation of Carbonaceous Materials at Low Temperatures. R. E. Jones and D. T. A. Townend. 56. Kinetic Aspects of the Combustion of Solid Fuels. J. R. Arthur, D. H. Bangham and Miss J. R. Bowring. 57. Mechanism of Carbon Combustion. E. Mertens and L. Hellinckx. 58. The Hydrogen Content of Carbon Monoxide Flames. E. Sterling and J. R. Arthur. 59. A Study of Recombination Reactions of Active Particles Produced by an Electric Discharge in Water Vapor. John F. Byrne. 60. The Mechanism of Chain Initiation in the Thermal Reaction between Hydrogen and Oxygen. Bernard Lewis and Guenther von Elbe. 61. The Reaction between Hydrazine and Hydrogen Peroxide in the Liquid Phase. Alvin S. Gordon.

Flame Spectroscopy and Radiation. 62. The Determination of Flame Temperatures by Infrared Radiation. Shirleigh Silverman. 63. Radiation Studies on a Closed Combustion Chamber. George A. Hornbeck. 64. Spectroscopic Studies of Low-Pressure Flames. A. G. Gaydon and H. G. Wolfhard. 65. The Luminosities of the Flames of Some Individual Chemical Compounds, Alone and Mixed. H. F. Coward and D. W. Woodhead. 66. The Nonadiabatic Reaction between Carbon Monoxide and Atomic Oxygen. Ivan F. Weeks. 67. The Emission Spectrum of Carbon Dioxide at 4.3 u. E. F. Daly and G. B. B. M. Sutherland.

Burning and Detonation of Explosives. 68. The Spontaneous Ignition of Nitrocellulose. E. K. Rideal and A. J. B. Robertson. 69. The Thermal Initiation of Explosion in Liquid Explosives. A. J. B. Robertson. 70. Hot Spots and the Initiation of Explosion. F. P. Bowden and A. Yoffe. 71. Initiation of Detonation of Explosives. G. B. Kistiakowsky. 72. Transition from Deflagration to Detonation: The Physico-Chemical Aspects of Stable Detonation. A. R. Ubbelohde. 73. The Use of Ammonium Nitrate as a Solid Fuel to Provide Gas for Propulsive Purposes. J. Taylor and G. P. Sillitto. 74. Pressure Measurements in Gaseous Detonation by Means of Piezoelectric Gauges. William E. Gordon. 75. On the Condition of Stability of the Plane Detonation Wave. Stuart R. Brinkley, Jr., and John G. Kirkwood. 76. The Properties of Gases at High Pressures which Can Be Deduced from Explosion Experiments. H. Jones.

Thermodynamics of Flame Gases and Thermochemistry. 77. Computation of Thermodynamic Properties of Gases from Spectra with the Aid of Punched Card Equipment. Lydia Savedoff, Jack Belzer, and Herrick L. Johnston. 78 Estimated Thermodynamic Functions of Free Radicals in Combustion Gases. J. J. Ward and M. A. Hussey. 79. The Energy of Dissociation of OH. R. Edse. 80. The Vapor Pressure and Heat of Sublimation of Carbon. Paul Goldfinger. 81. A Note on the Calculation of Multicomponent Propellant Gas Compositions. G. F. Sachsel, M. E. Mantis, and J. C. Bell. 82. A Method for Calculating Simultaneous, Homogeneous Gas Equilibria and Flame Temperatures. Paul F. Winternitz. 83. Determination of the True Composition of the Products of the Theoretical Combustion with Oxygen and Oxygen/Nitrogen Mixtures at Temperatures up to 2,500°C. at Atmospheric Pressures. H. R. Fehling and T. Leser.

Experimental Techniques. 84. Temperature Measurement on Complex Flames by Sodium Line Reversal and Sodium D Line Intensity Contour Studies. H. M. Strong, F. P. Bundy, and D. A. Larson. 85. Measurement of Velocity and Pressure of the Gases in Rocket Flames by Spectroscopic Methods. F. P. Bundy and H. M. Strong. 86. The Use of Thermocouples in Streaming Exhaust Gas. Ernest F. Fiock, Lief O. Olsen, and Paul D. Freeze. 87. An Interferometric Method of Gas Analysis." H. Lowell Olsen. 88. Application of the Schlieren Method to the Quantitative Measurement of Mixing Gases in Jets. W. R. Keagy, Jr., and H. H. Ellis. 89. The Automatic Sampling of Gases at High Temperatures and Pressures. W. R. Wykoff, W. H. Zelinski, S. M. Davis, and W. T. Reid. 90. A Technique for the Investigation of Spray Characteristics of Constant Flow Nozzles. Jack H. Rupe.

Combustion in Engines and Rockets. 91. An Experimental Study of Two-Stage Combustion. Gordon W. Haddock and Ivan F. Weeks. 92. Some Problems in the Design of Combustion Chambers for Liquid Propellant Rocket Motors. B. N. Abramson. 93. The Spontaneous Combustion of Fuels Injected into a Hot Gas Stream. B. P. Mullins. 94. Factors Affecting Combustion Stability. R. D. Park. 95. Some Considerations in Determining the Optimum Propellant Combination for a Rocket-Powered Missile. T. F. Reinhardt and J. R. Piselli. 96. Photographs at 500,000 Frames per Second of Combustion and Detonation in a Reciprocating Engine. Theodore Male.

Gas Burners and Furnaces. 97. The Problem of Gas Temperature Measurement above 1,500°C. R. Mayorcas, W. Pritchard, and M. W. Thring. 98. Energy Transfer from Flame Gases to Solids. J. K. Kilham. 99. The Theory and Practice of Permeable-Lining Furnaces. D. C. Gunn and A. L. Roberts. 100. Researches in the Utilisation of Manufactured Gas in Great Britain. J. G. King.

Changes of Address

Since the Post Office Department does not as a rule forward magazines to forwarding addresses, it is important that the Institute be notified of changes in address 30 days in advance of publishing date to ensure receipt of every issue of the *Journal* and *Review*.

Notices should be sent directly to:

Institute of the Aeronautical Sciences
2 East 64th Street
New York 21, N.Y.

Student Branches

(*Continued from page 20*)

Clarkson College of Technology

The Branch was organized on November 17, with Stephen A. Murtaugh, Jr., presiding as Acting Chairman.

Benefits of student membership were explained, and copies of the REVIEW and JOURNAL were passed to all present.

A film, *Wright Builds for Air Supremacy*, was shown.

A second meeting was held on November 30, with 45 members attending. Two films were shown: *The ABC of G* and *Working on Air*. A short talk was given by C. Y. Yang, the faculty advisor, on *V-g* diagrams.

Cornell University

On November 28, L. S. G. Kovasznay, Professor of Aeronautics, Johns Hopkins University, presented a paper on "Present Status of Turbulence Research."

Professor Kovasznay reviewed the development of turbulence research and emphasized the interdependence between theoretical and experimental work. He discussed the earlier work done on the basis of statistical theories, using the idea of properties based on a mean turbulent velocity. He then explained the concept of isotropic turbulence and its importance in reducing the number of variables involved and concluded with mention of the still unsolved problems and likely direction for continuing work in the field.

University of Florida

R. B. Ault, Chief Maintenance Engineer, Eastern Air Lines, Inc., Miami, gave a talk on "The Part Engineering Plays in Eastern Air Lines" at the December 5 meeting. Chairman Charles E. Jordan presided, with 24 members present.

A film, *Flying Fisherman's Club*, was shown.

University of Illinois in Chicago

Two nontechnical films, *The Story of the Stratocruiser*, and *Martin 2-0-2*, were shown at the November 29 meeting. Chairman Joseph Gross presided, with 21 members present. Ray Kramer, Secretary-Treasurer, passed out I.A.S. membership cards and emblems.

At the December 13 meeting, Professor M. Z. Krzywoblocki spoke on "The Principles of Aircraft Design."

Illinois Institute of Technology

With Marvin Zelibor, the Chairman, presiding, members saw a film on *The Gyrosyn Compass* from the Sperry Gyroscope Company.

Six new members, F. K. Halwax, J. Behrend, D. Feare, M. Giordano, O. P. Flaa, and F. Von Moll, were added to the roster.

University of Kansas

Dr. Paul V. Faragher, Member of the Metallurgy Department and Head of Specifications for the Aluminum Company of America, gave a talk on "New Aluminum Alloys" at the November 17 meeting. Chairman John C. Adams presided, with 45 members present.

Massachusetts Institute of Technology

On November 29, 23 members heard Walter R. Haldeman, Chief, Flight Engineering Branch, C.A.A., talk on "Prototype Testing for Civil Aircraft Airworthiness." Chairman Charles E. Richbourg presided.

In addition, a film, *Martin 2-0-2 Structural Test*, was shown during the earlier part of the talk, in which Haldeman explained the necessity of C.A.A. Factory Agents working with industry on engineering analysis, mock-up, structural testing, and flight testing of a proposed prototype.

University of Minnesota

New officers for 1949–1950 were elected as follows: Chairman, Alvin D. Riedler; Vice-Chairman, Harlan E. Smith; Treasurer, Raymond E. Pates; Secretary, Erik Sparre; and Publicity Chairman, Alene G. Elsner.

On November 15, a talk on "Guided Missile Development" was given by Brig. Gen. E. H. Salzman, U.S.M.C. (Ret.), after the showing of a motion picture in color entitled *Operation Sandy*. The film showed the launching of a V-2 from an aircraft carrier and related some of the problems involved, training of personnel, assembly and erection of the missile, type of launching platform used, and other topics.

General Salzman talked of the development of guided missiles in the Navy and described some of the difficulties experienced shortly after the war in obtaining qualified personnel.

North Dakota Agricultural College

A joint meeting was held on November 22 with the student branch of the American Society of Mechanical Engineers.

A discussion was held on improving the speaking ability of the engineering students.

Speaker of the evening, Mr. Sanderson, Head of the Weather Bureau, Fargo Airport, described the functions of the Weather Bureau and explained the procedure of weather predictions.

On November 25, five members accompanied Professor R. K. Watson, Honorary Chairman, to Holman Field, St. Paul, Minn., for an inspection trip through Northwest Airlines' Maintenance Depot.

The tour was conducted under the guidance of L. E. Geror, Director of Mechanical Operations for Northwest Airlines, Inc.

University of Notre Dame

The Aviation Editor of the *South Bend Tribune*, Edward Scheuer, gave a talk on "The Problem of Informing the Public of the Advances in Aviation" at the November 17 meeting. Chairman Walter Geudtner presided, with 25 members present.

On December 1, Harold Hawkins, Professor of Civil Engineering, Illinois Institute of Technology, spoke on "Conditions in Postwar Europe." His talk was accompanied by color slides.

University of Oklahoma

On November 9, in addition to two films, *NACA Research* and *The Story of the Stratocruiser*, talks were given by Student Members Bill Sprague and Francis Ford.

Mr. Sprague, in "My Summer Job in the Aircraft Industry," described his duties in computing and recording data from supersonic wind-tunnel tests for Consolidated Vultee Aircraft Corporation's plant in Daingerfield, Tex.

Mr. Ford spoke on the "Caster Landing Gear," which was illustrated by a cutaway model.

Parks College of Aeronautical Technology

At a business meeting on December 1, a Program Committee was appointed for the present term, as follows: Chairman, Robert Riley, and members, Joseph Traybar, John Wardein, and George Holland.

Rensselaer Polytechnic Institute

"Compound Engines" was the subject of a talk given on November 16 by Robert L. Johnson, Chief, Field

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November 11, 1949

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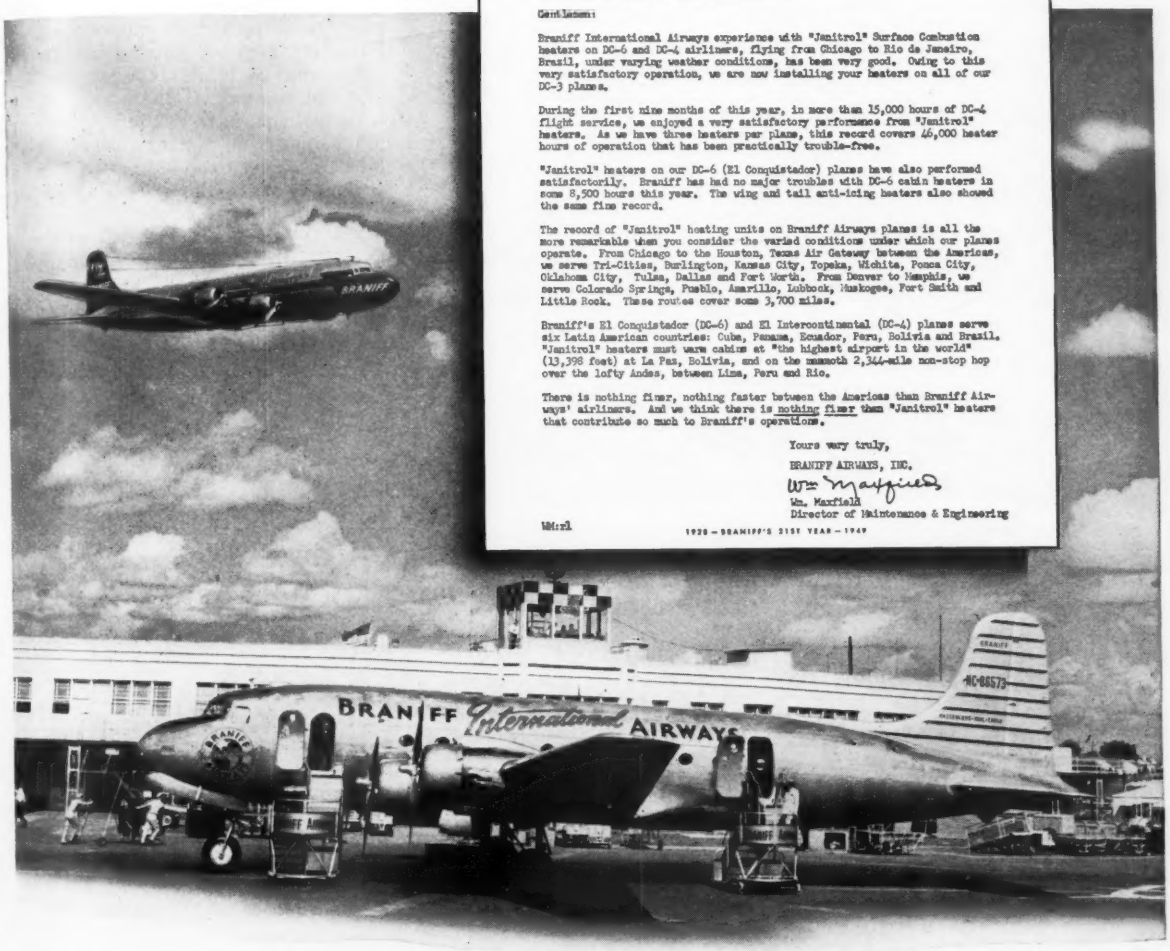
1928 – BRANIFF'S 21ST YEAR – 1949



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Photos Courtesy United Helicopters, Inc.

Rotary wing aircraft design is being advanced on the Pacific Coast by United Helicopters, Inc. in Palo Alto, California. The Hiller "360" Helicopter which takes its name from the company's president, Stanley Hiller, Jr., starred recently in a sensational rescue of an injured boy hiker in the Benson Lake Region of the high Sierras, 8100 feet altitude.

(Left) Cannon Electric type AN3106B Plug with AN3057 Cable Clamp and AN3102A Receptacle on sub-assembly of the "360".

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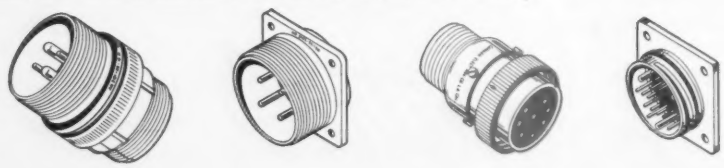

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Engineering Division, Wright Aeronautical Corporation, before 50 members. Chairman William B. Brower presided.

According to Mr. Johnson, future engine trends would see the turboprop replace the jet for long-range high-pay-load operations. Today the jet is being pushed extensively, according to Johnson, who questioned the wisdom of it. The jet, he declared, is an inflexible type—it must fly high and fast. The turboprop, on the other hand, is more flexible.

The speaker showed some slides on the construction and operation of the Wright Turbo-Cyclone engine and the 18-cylinder, air-cooled piston engine with three exhaust-driven turbines "feeding back" to the crankshaft.

Spartan College of Aeronautical Engineering

Myron W. DeGeer, U.S. Civil Engineers—Tulsa Branch, Advance Planning Department, spoke on "Organization and Problems of the Civil Engineers" at the November 1 meeting. Chairman Robert N. Messerly presided, with 59 members present.

At the November 15 meeting a film, *PBM-3 Wing Destruction Test*, was shown. Members present totaled 64.

Syracuse University

H. M. Wales, General Electric Company, Syracuse, gave a talk on "Résumé of Aviation Electronics" before 22 members and the Chairman, Philip R. Woodford, at the November 9 meeting.

In addition, a film on *Commercial Aviation Radar*, by General Electric, was shown.

Texas A. & M. College

Chairman William A. Klabunde opened the November 15 meeting with a brief discussion of the Engineers Council and its function. Thirty-five members were present.

A film, *Power by Wright*, was shown, which told the complete story of the origin of the Wright Cyclone engine.

Tulsa University

The November 17 meeting featured W. E. Olds, Senior Student, who spoke on "Development Difficulties of the F-84 and Its G-E Engine," and T. R. Shockey, Senior Student, author of "Heat Resistant Alloys."

Chairman K. Murty introduced the speakers.

University of Wichita

Dr. Penrose Albright, Head, Department of Physics, gave a lecture on "Atomic Energy" at the November 9 meeting, which was attended by 19 members. Chairman Daniel S. Carl presided.

Following the lecture two short films were shown: *Atomic Energy* and *Atomic Power*.

News of Members

R. Bussiere, M.I.A.S., formerly Senior Weights Engineer for Republic Aviation Corporation, now is Project Engineer, American Power Jet Company, Montclair, N.J. Home address is 50 W. 88th St., New York, N.Y.

Major Daniel D. Champlain, U.S.A.F., T.M.I.A.S., has been transferred to A.P.O. 239, San Francisco, Calif., from Dow Field, Bangor, Me.

Adolf C. Falk, M.I.A.S., is Owner and Chief Engineer, A. C. Falk Engineering Service, Huntingdon Valley, Pa.

Leonard S. Ganz, T.M.I.A.S., is with Sperry Gyroscope Company as Field Service Representative. He was formerly Vibration Engineer, Piasecki Helicopter Corporation. Home address is 251 Ft. Washington Ave., New York 32, N.Y.

Frank E. Goddard, Jr., M.I.A.S., has recently joined the Jet Propulsion Laboratory at California Institute of Technology as Chief of the Wind Tunnel Section. New address is 421 Wistaria Place, Altadena, Calif.

Stanley A. Hall, M.I.A.S., has been elected to fill the office of President of the Southern California Soaring Association, Inc., outstanding motorless flying organization. He will lead soaring experiments to altitudes of 30,000 ft. and higher in the Bishop, Calif., area.

Dr. R. W. Hambrook, M.I.A.S., no longer is Adviser to the Ministry of Education in Ethiopia. New address is c/o Cecil Stoughton, 130 Melick Ave., Honolulu, Hawaii.

J. I. Hamilton, M.I.A.S., has been appointed General Sales Manager, Menasco Manufacturing Company, Burbank, Calif. A graduate of M.I.T., he was with Curtiss-Wright Corporation for 10 years and held the position of Assistant Sales Manager for past 5 years.

Thomas A. Holgate, M.I.A.S., formerly Senior Aerodynamicist for The Glenn L. Martin Company, is now with Boeing Airplane Company (Seattle) as Aerodynamicist "A." Address is 1534 Grand Ave., Seattle 22, Wash.

C. R. Johnson, M.I.A.S., formerly Senior Engineer for the Shell Oil Company, is now with Shell Chemical Corporation, Box 211, Torrance, Calif.

S. Krishnan, M.I.A.S., has returned to India following duty as Technical Observer at American Airlines, La Guardia Field, N.Y. New address is 728 Fifth Cross Road, Bangalore, South India.

William H. Lane, T.M.I.A.S., is an Aeronautical Research, Development, and Design Engineer for Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio. New address is 51 Cambridge Ave., Dayton.

O. L. Mossberg, M.I.A.S., is Research Leader, Exterior Ballistics, A. B. Bofors, Bofors, Sweden. He has been Aerodynamics Type Leader, SAAB Aircraft Company, Linkoping, Sweden.

1st Lt. Charles A. Neyhart, U.S.A.F., T.M.I.A.S., is stationed at A.P.O. 74, San Francisco, Calif. He is with the 13th Air Force.

Eric Olsen, M.I.A.S., is engaged in his own engineering and photography business doing ultra-high-speed work on various engineering problems. New address is 1431 Gilbert St., Hayward, Calif.

Robert G. Porter, M.I.A.S., formerly with the Pilotless Aircraft Section of The Glenn L. Martin Company, is now Guided Missiles Engineer for Army Ordnance at the Pentagon Building, Washington, D.C.

E. W. Saben, M.I.A.S., is Director (Technical) of H. T. Sims & Company Ltd., 4 Albemarle St., Piccadilly, London, W.1, England.

Milton H. Sheppard, Jr., T.M.I.A.S., is with the NEPA Division, Fairchild Engine and Airplane Corporation. New address is 1603 E. Magnolia Ave., Knoxville, Tenn.

George Sonneman, T.M.I.A.S., has been promoted from Instructor to Assistant Professor, Mechanical Engineering, Drexel Institute of Technology.

Cecil E. Spruill, T.M.I.A.S., is now Structures Engineer for Grumman Aircraft Engineering Corporation. New address is 125 Clinton Ave., Huntington, L.I. N.Y.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Cary, Charles O., Executive Secretary, Air Coordinating Committee (Washington, D.C.).

Stewart, Homer J., Ph.D. in Aero., Prof. of Aeronautics & Chief, Research Analysis Section, Jet Propulsion Lab., California Institute of Technology.

Elected to MEMBER Grade

Browder, Jay E., Engineering Section Head, Sperry Gyroscope Div., The Sperry Corp.

Caldwell, David C., B.S., General Mgr., Bowers Mfg. Co. (Los Angeles).

Gale, Merlin H., B.S.Ae.E., Airframes Engineering Group Supervisor, U.S. Naval Air Station (San Diego).

Humphries, Douglas G., B.E., Chief Designer, Commonwealth Aircraft Corp. Pty., Ltd.

James, Richard E., M. of Engrg. Mech., Asst. Prof. of Mech. Engineering, New Mexico College of A. & M. A.

Light, Edward C., B. of Ae.E., Chief Engineer, Summers Gyroscope Co.

Overholser, J. Homer H., Vice-President & Chief Engineer, Hydro-Aire, Inc.

Smith, Richard C., B.S. in E.E., Design Engineer, Bell Aircraft Corp.

Tawney, Gerald L., Sc.D. in Applied Physics, General Mgr. & Treasurer, Atlantic Electronics Corp.

Transferred to MEMBER Grade

Bailey, C. Odgen, M.S.Ae.E., Instructor in Aero. Engrg., Oregon State College.

Forsyth, Charles M., B.S.E. in Ae.E., Project Flight Test Engineer, McDonnell Aircraft Corp.

Gardenier, Hugh E., B.S. in Ae.E., Aerodynamicist, Sverdrup & Parcel, Inc.

Goldman, Jerome M., B.S.Ae.E., 2nd Officer, Pilot & Flight Engineer, United Air Lines, Inc.

Grossman, Norman, M.S. in Math., Sr. Research Engineer, Republic Aviation Corp.

Kaplan, Leon, M. of Ae.E., Structural Engineer, Edo Corp.

Kircher, Lawrence G., M.S. in Ae.E., Instructor in Aero. Engrg., University of Minnesota.

Overbey, James T., B.S. in M.E. (Aero.), Dir. of Wind Tunnel, University of Oklahoma.

Potter, John L., M.S., Asst. Prof., University of Alabama.

Stokke, Allen R., B. of Ae.E., Sales Engineer, Lord Mfg. Co.

Ulrich, Benjamin H., Jr., M.S. in Ae.E., Research Asst., Combined Stress Lab., The Pennsylvania State College.

Villalba, Ivan P., M. of Ae.E., Stress Analyst, Grumman Aircraft Engineering Corp.

Elected to Associate Member Grade

Angstadt, Ira F., Managing Editor, "Aero Digest."

Elected to Technical Member Grade

Avant, William W., B.S. in Ae.E., Research Engineer, Ram Jet Combustion Section, North American Aviation, Inc.

Lakshminarayana, C. N., B. of Engrg., Scientific Officer, In Charge of the Wind Tunnel, Indian Institute of Science, Dept. of Aeronautics.

Miller, Frank F., Mathematician "A," North American Aviation, Inc.

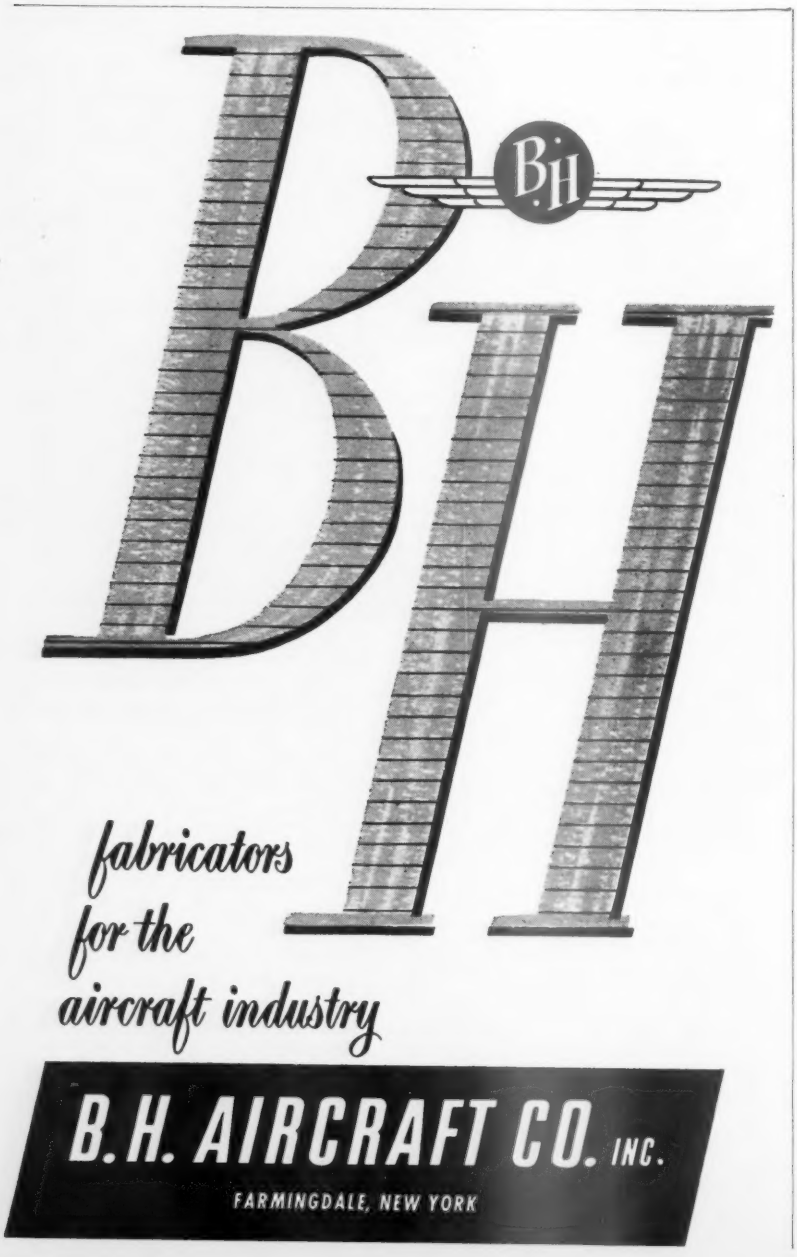
Morgan, George Richard, B.S. in M.E., Mathematician "B," North American Aviation, Inc.

Rathbone, J. A. Thomas, Aero. Draftsman, David Taylor Model Basin, Navy Dept. (Maryland).

Transferred to Technical Member Grade

Barton, Charles K., B.S.Ae.E., Graduate Asst., Case Institute of Technology.

Belluardo, R., S.B., Stress Analyst, Piasecki Helicopter Corp.



Bourke, E. R., II, B.S., Preliminary Designer, Bell Aircraft Corp.

Bower, Robert E., M.A.E., Research Engineer, Aerodynamics, Grumman Aircraft Engineering Corp.

Bracke, Peter P., B.S., Aero. Engineer, Air Materiel Command, Wright-Patterson Air Force Base.

Brooks, T. Preston, B.S. in Ae.E., Sr. Stress Analyst Asst., McDonnell Aircraft Corp.

Brown, Stuart C., M. of Ae.E., Aero. Research Scientist P-2, Ames Aero. Lab., N.A.C.A.

Brown, Walter W., B.S. in Ae.E., Lt. & Navigator, U.S.A.F.

Carlyle, Lester, B. of Ae.E.

Corliss, Lorin D., B.S. in Ae.E., Draftsman, North American Aviation, Inc.

Dahl, Wesley N., A.A. in Ae.E., Detail Draftsman, Greenlee Bros. & Co.

Dalton, John H., B.A. (Physics), Student, Massachusetts Institute of Technology.

Denardo, B. Pat., B.S., Aero. Engineer P-1, Ames Aero. Lab., N.A.C.A.

Depew, Noel F., Tooling Master Layout Draftsman, Boeing Airplane Co. (Wichita).

Dolan, Robert B., Data Reduction Clerk "A," North American Aviation, Inc.

Doyle, William P., B.S.

Dugan, James W., B.S.Ae.E.

Erchinger, Donald B., B.S. in Ae.E., Service Engineer, Boeing Airplane Co. (Seattle).

Fenne, Donald W., B.S. in Ae.E., Graduate Student, University of Minnesota.

Foland, Douglas H., B.S.Ae.E., Aero. Engineer, N.A.C.A., Langley Air Force Base.

Fraser, J. Perry, M. of Ae.E., Rotating Engineering Program, General Electric Co. (Schenectady).

Frassinelli, Guido J., M.S.

Frieze, Conrad R., B.S.M.E. (Aero.), Jr. Engineer, Tool Design, Boeing Airplane Co. (Seattle).

Gareri, Dan J., M.S. (Aero.), Captain & Flying Officer, U.S.A.F.

Glaser, Maxine R., B. of Ae.E., Engineer, Seibel Helicopter Co., Inc.

Gorowitz, Harold, B.S. in Ae.E., Aero. Engineer P-1, N.A.C.A. (Moffett Field).

Goulet, Jean L. J., B.S.

Griffith, Franklin P., B.S. in Ae.E.

Heady, Roy T., B.S.Ae.E.

Henz, Edward F., B.S.Ae.E.

Hertz, Rudolf J., Major, U.S.A.F.; Asst. Chief, Special Arctic Projects Div. Hq. & Hq. Sqdn., A.A.C.

Jennings, Hugh A., B.Ae.E., Jr. Drafting Engineer "B," Boeing Airplane Co. (Seattle).

Johnson, D. H., B.A.E., Draftsman "B," North American Aviation, Inc.

Klopfenstein, H. Wayne, B. of Ae.E., Jr. Engineer "A," Boeing Airplane Co. (Seattle).

(Continued on page 93)

Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to Aeronautical specialists. any member or organization may have requirements listed without charge by writing to the Secretary of the Institute

WANTED

Physicist—For design and development of electronic and mechanical instrumentation equipment used in the pursuit of flight-research work. Several years of theoretical and practical experience necessary. Salary commensurate with qualifications. Permanent position. Give details in first letter. Cornell Aeronautical Laboratory, Inc., 4455 Genesee Street, Buffalo 21, N. Y.

Research Assistant—A half-time research assistantship, paying about $112 per month and sponsored by the N.A.C.A., is available in the Department of Engineering Mechanics at the Pennsylvania State College starting February 1, 1950. The work deals with the experimental and theoretical study of behavior of metals subjected to combined stresses in the plastic range. The research work could be used for a Master's or Doctor's thesis in Engineering Mechanics. If interested, please write to Professor Joseph Marine, Department of Engineering Mechanics, The Pennsylvania State College, State College, Pa.

Professor of Aeronautical Engineering—To teach senior and graduate work in aerodynamics, aircraft design, and compressible fluids; conduct research. Administrative and wind-tunnel experience desirable. Degrees: Ph.D., D.Sc., or equivalent. Salary open. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis 14, Minn.

Research Engineers—To perform studies on combustion problems; aid in development testing of ram-jet engines. Applicant must have experience in some phase of combustion as applied to ram-jet, turbojet, or pulse-jet engines. Ability to write acceptable reports considered important. **Aerodynamics Engineer**—With advanced degree to perform studies in aerodynamics and thermodynamics. Knowledge of supersonic aerodynamics required. Must have some knowledge of jet-power-plant field, preferably with ram-jet engines. Positions available with progressive young company on West Coast for qualified persons. Salary dependent upon qualifications. Marquardt Aircraft Company, 7801 Hayvenhurst Ave., Van Nuys, Calif.

118. Laboratory Supervisor—West Coast aircraft manufacturer needs Laboratory Supervisor with broad experience in aircraft laboratory work and special ability in the field of high-temperature steel application. Knowledge of electronics also desired. Excellent living conditions, stable employment, and opportunity for advancement available. Inquiries should include education and experience summary.

AVAILABLE

126. Aeronautical—Mechanical Engineer—B.S. Aero Engrg., University of Michigan. Age 29. One year's experience in aircraft production, design, and stress analysis. Three years' experience in operation and maintenance of Naval aircraft. Four years as project engineer of plant expansion program entailing equipment design, layout, purchasing, installation, and operational follow-up. Holds private pilot's license. Registered Professional Engineer, Commonwealth of Massachusetts. Will complete requirements for B.B.A. in Management, June, 1950. Desires position in planning or development group.

125. Company Representative—Aeronautical Engineer—Test Pilot—B.S. in Ae.E., M.I.T. (1940); also holds A.B. degree; current post-graduate work in aeronautical engineering Graduate of Navy Test Pilot Training School with $1^1/_2$ years' experience as a project test pilot in the Flight Test Division, N.A.T.C., Patuxent River, Md. Fifteen years' total pilot experience in 79 types of aircraft; 9 years as Naval Aviator; 3,800 hours pilot time. Qualified in single- and multiengine land and seaplanes, jets, and helicopters. Two and one-half years' civilian aeronautical engineering experience in manufacturing, overhauling, and repairing; 3 years' military aircraft maintenance. Familiar with military aircraft specifications and design requirements. Age 32; desires position utilizing combined aeronautical experience in which personal military contacts would be of value, such as company sales representative. Flight test or engineering position acceptable as a start. Available for interview; location open.

124. Aeronautical Engineer—B.S. Aeronautical Engineering, M.I.T.; Age 23; single. One year's experience as Liaison Engineer. Three months as draftsman. Interested primarily in stress analysis. Location open.

123. Aeronautical Engineer—B.S. in M.E. (Aero.), June, 1949, Carnegie Institute of Technology. Working as design engineer since graduation. Four years in U.S.A.A.F. as B-26, 9th A.F. pilot. Completed 9 months' course as aircraft maintenance officer (partly jet engines). Desires position in aircraft engine industry, preferably jet or rocket. Location open. Age 28; married.

122. Aerodynamicist—Many years' research experience with leading Government organization. Six years with two large aircraft manufacturers. Extensive knowledge of wing characteristics. Considerable experience with wind-tunnel testing and general knowledge of aerodynamics. Married; West Coast preferred.

121. Engineer—Pilot—B.S.M.E. (Aeronautical); 3 years engineering design; 4 years naval aviator; 3 years flight-test engineering; 3,000 hours single- and multiengine; C.A.A. commercial and instrument rating. Prefers pilot position, test, production, or other executive work.

120. Aeronautical Engineer—Graduate of the Academy of Aeronautics course, "Design and Construction." Holds C.A.A.—A. & E. license issued in 1943. Experienced in sheet-metal structures with leading air carrier. Flight engineer with cold Weather Test Detachment in Alaska service-testing B-17 airplane. Experienced in high-frequency radio control of model aircraft. Desires position in research or testing. Age 26; married. Location open.

119. Aeronautical Engineer—Extensive experience in flight research, wind-tunnel testing, and design, specializing in applied aerodynamics and stability and control. Capable project leader, or will work alone. Age 32. Must locate in California or the Southwest.

117. Aeronautical Engineer.—B.Aero.E., New York University, October, 1949. Age 25; married. One and one-half years' machine-shop experience with aircraft-engine manufacturer; 2 years business office responsible position. Desires position in aircraft or allied manufacturing.

115. Airline Operations Engineering—Airport Management—Training at Denver University, Parks College, and Spartan School of Aeronautics in operations and meteorology and technical writing. Four years A.A.F. Intelligence dealing with restricted and confidential manuals in maintenance and Air Transport Command flight operations. Familiar with air-line operations problems at large Eastern airports. Also trained in A.A.F. 1st Helicopter Training Unit. Has postwar training in latest sales and airport and aircraft insurance underwriting procedures. Prewar aeronautical engineering training at V.P.I. Extension and at University of Alabama. Desires position with large fixed-base or as airport management assistant.

114. Practical Research Engineer—Civil Service Rating; Age 43. Fifteen years' aeronautical research and development experience in stability and control, specializing in high-lift and boundary-layer devices. Improved high-speed propeller designs, jet and tailless aircraft, missile designs, etc. Coordinating wind-tunnel and full-scale work. Pilot—graduate engineer. U.S.A.F.—2 years' Wright Field Technical Aide, research engineer.

113. Aeronautical Engineer—Structures—Nine years' experience with leading aircraft manufacturers since 1940. Two years as Group Structures Engineer in charge of structural design, checking, and report preparation for major components of airplane, supervising the activities of up to 10 engineers. Also preliminary design experience in structures. Has worked with both military (Army and Navy) and commercial airplanes. Two years' experience as Field Service Engineer. Graduate engineer. Age 35; married. Any location suitable.

112. Aeronautical Engineer—B.S. in Ae.E., Pennsylvania State College, June, 1949. Pilot experience during war. Desires starting position in aircraft design, development, research, or testing work. Age 26; single. Location open.

111. Engineer—Sales or Administrative—Ten years' experience in design, test, development of military aircraft. Bachelor's degrees, Purdue and Stanford Universities. Formerly officer, Marine Corps aviation. Sales engineering experience, power plant and accessories; well acquainted with A.M.C. and BuAer, N.A.C.A. and C.A.A. Age 32; will travel anywhere; licensed pilot.

110. Aeronautical or Mechanical Engineer—B.S. Degree in Aeronautical Engineering. Graduate student for $1^1/_2$ years in Aeronautics and Applied Mechanics. Approximately 3 years in the aircraft industry as a senior draftsman and aerodynamicist. Desires a position in stress analysis or aerodynamics and other related engineering work. Will accept position anywhere in the U.S. or abroad.

105. Manufacturers Military Sales Representative—Aeronautical Engineer; B.Ae.E. Fourteen years' experience both in the aviation industry and in the Air Materiel Command at Wright Field. Positions in industry included project engineer, staff engineer, and factory representative to the Air Materiel Command, covering both technical and administrative duties. Duties with A.M.C. included design, stress analysis, airplane project engineer, which afforded close and frequent contact with both A.M.C. and aviation industry engineers. Can be of value to aeronautical equipment manufacturer seeking A.F. contracts or currently a contractor to the A.F.

104. Aeronautical Engineer—B.S.A.E.; Age 33. Ten years' aircraft engineering, design, and fabrication experience, including stress analysis

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

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and testing, design group leader on surfaces, controls, and power-plant installation, assistant project engineer. Present position, Design Engineer. Familiar with Army, Navy, and C.A.A. requirements. Interested in new design and development. Available on 30 days' notice. Location open.

103. Aeronautical Engineer—Bachelor of Aeronautical Engineering, 1949; graduate of New York University, College of Engineering, Two years, 1940–1942, N.Y.U. College of Arts and Sciences. Single; age 27. Member of Officers Reserve Corps (1st Lt.—Air Force). Three years' flight experience in heavy bombardment aircraft (B-17's, B-24's) as navigator during the war. Was combat navigation instructor to B-17 crews, 1944–1945, after service with 15th A.F. in Mediterranean Theatre. Has received P-1 Rating as Aeronautical Engineer with Air Materiel Command at Wright-Patterson Air Force Base as of April, 1949. Ten years' experience in use of Leica photographic equipment in all phases of 35-mm. photographic work. Desires position with aircraft company offering opportunity for a variety of experience and willing to locate anywhere in the U.S. Complete résumé sent upon request.

102. Aeronautical & Mechanical Engineer—B.S.E. in Aero. and Mechanical from University of Michigan. Ten years' experience as design engineer, spares engineer, and head of engineering release department with one of the major aireraft manufacturers. Also 3 years' experience in the field of electronics as research mechanical engineer and mechanical development engineer. Prefers position on West Coast in research, development, design, or administrative engineering. Age 36; married.

100. Model Specialist—Precision wind-tunnel airplane-model builder; also all types of experimental machinist work done. Facilities for private contract work.

99. Aerodynamicist—B.S. in A.E.; 10 years' experience in theoretical aerodynamics, specializing in stability and control problems with government aeronautical research organization. Last 4 years engaged in theoretical supersonic aerodynamics. Desires theoretical research work in high-speed aerodynamics which may include some time in teaching theoretical aerodynamics.

98. Aeronautical Engineer—Bachelor's Degree in mechanical engineering with graduate study in mathematics and aerodynamics. Six years of experience as project engineer in theoretical and wind-tunnel research in the subsonic and transonic speed ranges with specialty in stability and control.

97. Contract Administrator—Administrative Engineer—Graduate engineer with 23 years' experience in the aviation industry, covering aircraft and engine manufacturing and active duty during the World War II in the Bureau of Aeronautics. Positions held have included responsible duties in engineering, financial, and administrative work in most of which there was frequent contact with Government agencies, United States and foreign engineers and technicians. Most recently General Manager of a Research and Development contact coordinating opinions of authorities throughout aviation and allied sciences.

Members Elected

(*Continued from page 90*)

Landers, Charles B., B. of Ae.E., Aero. Engineer P-1, Structures Research Div., N.A.C.A., Langley Air Force Base.

Linn, Dudley P., B.S., Graduate Student, A. & M. College of Texas.

Logan, Lewis B. C., B.S., 1st Lt. & Pilot, U.S.A.F.; Asst. Adjutant & Personnel Officer, Det. A., 10th Rescue Sq.

Loy, Raymond E., B.S. (Aero.), Jr. Stress Analyst, NEPA Div., Fairchild Engine & Airplane Corp.

Luck, Lucille D., B.S., Asst. Scientist, Aero. Engineering Dept., University of Minnesota.

Madsen, Jack, B.S., Design Draftsman "A," Douglas Aircraft Co., Inc. (Santa Monica).

Marques, Jose L., B.S.

Miller, James W.

Myers, Joseph R., M.S. in Ae.E., Captain, U.S.A.F.; Project Officer & Test Pilot, Wright-Patterson Air Force Base.

Payne, William H., B.S.Ae.E.

Perper, Dirk N., B. of Ae.E., Vibration Engineer, Douglas Aircraft Co., Inc. (Santa Monica).

Richard, Charles H., A.A. in Ae.E., Parts Lister, Consolidated Vultee Aircraft Corp. (Ft. Worth).

Roosa, Lewis H., S.B., Aero. Engineer, David Taylor Model Basin (Carderock).

Róss, Russell H., M. of Engrg., Aerodynamicist, Douglas Aircraft Co., Inc. (Santa Monica).

Rounds, James M., M.S. in Ae.E., Captain, U.S.A.F.; Research & Devel. Officer, Holloman Air Force Base.

Sachs, Donald G., B. of Ae.E., Jr. Engineer "B," Boeing Airplane Co. (Seattle).

Schabacker, Paul H., Tool Designer "C," Douglas Aircraft Co., Inc. (Long Beach).

Schultz, Donald L., B.S.

Shank, Robert E., B.S., Mathematician "B," Air Loads Group, North American Aviation, Inc.

Shelton, Frank A., Jr.

Siegel, Gordon I., B.S., Captain, U.S.A.F.; Project Engineer, Design Branch, Aircraft Lab., Air Materiel Command, Wright-Patterson Air Force Base.

Spieth, Charles W., B.S., Engineer, Experience Program Group, Beech Aircraft Corp.

Stoops, Ernest S., B.S., Mathematician "A," Doulgas Aircraft Co., Inc. (El Segundo).

Swartzwelder, Joseph H., B.S. in Ae.E.

Sweeney, Edwin F., B.S. in Air Transportation, Captain, U.S.A.F.

Tatnall, George J., B.S.M.E., Designer, Naval Air Development Center (Johnsville).

Wagner, Clifford E., B.S.

Weatherup, Robert A., A.E., Lt. Cmdr. & Naval Aviator, U.S.N.; Asst. Head of Power Branch, Office of Naval Research.

Wickham, Charles G., M.S., Stress Analyst, Douglas Aircraft Co., Inc. (El Segundo).

Wiedmuller, William J., Assemblyman, Liberty Aircraft Products Corp.

Wilkie, Lloyd E., S.M., Aerodynamicist, Northrop Aircraft, Inc.

Wyss, John A., M.S., Aero. Research Scientist, Ames Aero. Lab., N.A.C.A.

I.A.S. National Meeting Schedule

Fifth Annual Flight Propulsion Meeting—Hotel Carter, Cleveland—March 24

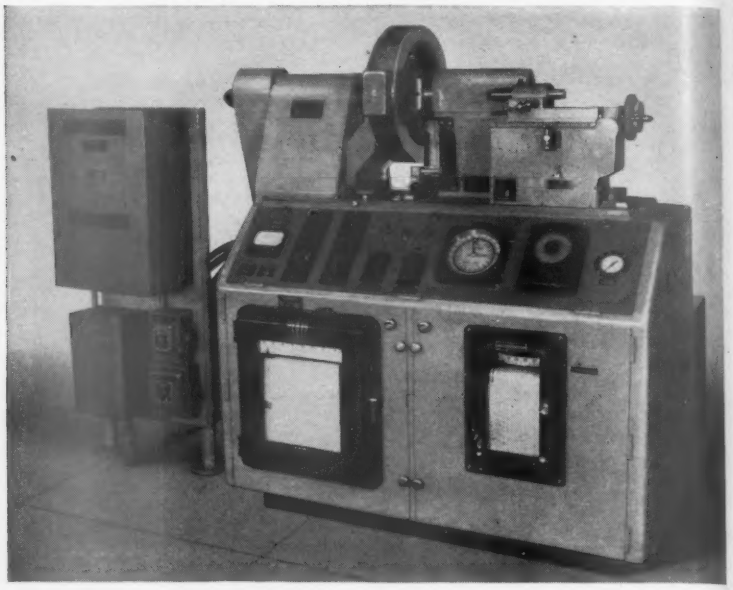
Annual Summer Meeting—Western Headquarters Building, Los Angeles, July 11–14

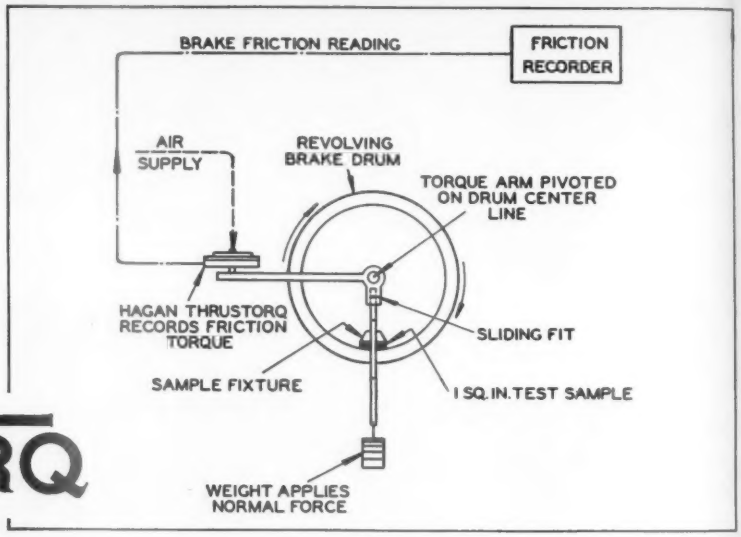
Members or organizations wishing to submit papers for presentation at National Meetings should send outlines or summaries to the Committee at least 3 months prior to the meeting.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to
The Meetings Committee
Institute of the Aeronautical Sciences
2 East 64th Street, New York 21, N.Y.

New BENDIX brake-testing machine incorporates HAGAN THRUSTORQ





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1949 AERONAUTICAL ENGINEERING CATALOG

The only publication of its kind devoted exclusively to the aircraft industry, this CATALOG serves as a valuable buyers' and reference guide to sources and specifications on aircraft materials, parts, and accessories. It is distributed annually to Chief Engineers, Designers, Production Heads, and Purchasing Departments of all leading Aircraft, Aircraft Engine, Instrument, Accessory, and Aircraft Parts Manufacturers; Air Transport Companies; Army, Navy, and Governmental Agencies; Research Organizations; Engineering Libraries; etc.

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